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LABORATORY WORK IN HIGH SCHOOL GEOGRAPHY.[1]

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INTRODUCTION.

During the last twenty years our secondary school geography has been discussed from almost all possible points, and it might seem that little more could be said. I shall not at this time claim to have something new to present, but will mention briefly a few points that appeal to me.

By way of introduction to our specific subject, let us take stock of our present condition. There have been many complaints that geography is losing ground as a science, scattering its force, and becoming a mere jumble of unrelated facts. This is transitional. The purely physical geography was abused and is being replaced by something better; and in the process of changing many things are being tried, some to remain, some to be cast aside. Here is the chief cause for the present confusion.

But to-day the signs are encouraging. Three generations of text-books have come out since the Report of the Committee of Ten. Each has departed farther than its predecessor from the spirit of that report, and each has come closer to what the more advanced secondary schools are now calling for. I think the last generation of books would have fitted very well, had it arrived three or four years earlier; but the trend of the call is decidedly away from physical geography, from the physical, systematic side; and towards the correlation of physical with human elements—industrial, commercial, ethnical, and even ethical and religious elements. And the books are becoming less systematic and more humanistic, and likewise, more geographic. I have recently learned that a still further advance is now being prepared. I await it with interest. I know it will be good.[2]

Again we are doing much better and much more laboratory work than was done a few years ago. It has been my privilege

[1]Read March 29, 1912, before the Association of Ohio Teachers of Mathematics and Science.

[2]Since writing the above two new books have appeared in this category: one by a normal school teacher, the other three university men.

to examine high school laboratory notebooks. Not many years ago I read a notebook in physical geography, submitted for college entrance credit, which had absolutely nothing in it but a considerable collection of half-tone pictures of scenery. They had been clipped from newspapers, railroad folders, and the like. There was not a note or comment to tell what the scenes stood for, either in their original setting or physiographically—no writing but the pupil's name, his school, and the teacher's O. K. and signature. I have no doubt this was some poor teacher's honest effort to meet the requirement of laboratory work. I have wished I might know that teacher. But many excellent notebooks have recently been examined, and I am satisfied that we have made notable progress in this branch of work in the last five or six years. Some six or eight laboratory manuals, from which we can select, are now on the market. These will serve as helps for the teacher whose lack of preparation, experience, initiative or interest makes it imperative that he have such aid.

A third indication that the science is gaining standing in the secondary schools is in the fact that there are more better-trained geography teachers, and fewer with no training, in the schools than there were a few years ago. There are proportionately fewer who are teaching the course under protest than formerly. I believe nothing has done more to discredit the subject with school men and disgust pupils than the fact that it has been necessary to put the classes into the hands of persons not in the least prepared, either by aptitude, desire, or training, to teach the subject. If latin or history had been so largely intrusted to such hands for ten or fifteen years they would have suffered as much as has the geography.

Fourth, and best of all, more people than ever before are actually, earnestly, trying to solve the problem of an effective course in secondary school geography. Various plans have been tried and discussed, and tried again. Teachers meet together to discuss their difficulties and report their success; papers have been written by the dozen in recent years. Several of these have appeared in the *Journal of Geography*. One of the best was by the editor in a recent number. Many who are competent have been organizing the material so that one without all desirable training will know what to use and what not to use. Along this line, nothing better could fall into the hands of the geography teacher than the *Journal of Geography*, edited by Professor R. H. Whitbeck of the University of Wisconsin.

The course has been somewhat of a filler, of which the secondary school has had too many. I find now a multitude who are working to give it instead a specific place and a unity. There seems to be a purpose to make it a bit of scientific training in reasoning and an informational course, along humanistic lines.

Whatever is done in geography (and this applies to all parts of the course as well as to the laboratory work) we must do something worth while. If it has no place in the school, no one who can give it well or at least has interest enough to try to give it well, I should question the advisability of giving it at all. Leave it out a year until an efficient teacher can be found. We should no longer think of giving the course simply as a filler or as a general science jumble. In this condition it is a bugbear to the teacher, of no real value to the pupil and is not desired by the colleges.

Principles Underlying Laboratory Work.

Some fundamental principles might be stated to direct one in the selection of laboratory work or exercises.

1. The work should be within the power and interest of the pupils.
2. It should elucidate or supplement the text or class room work, but deal with concrete things, while the text and its discussion should work out the generalizations and principles.
3. It should develop the student's power of observation, thought and reasoning. For example, it should set problems to solve, and it should be specific.
4. It should not aim specifically to develop technique or skill.
5. It should not be too technically systematic but decidedly humanistic. The physical should be called in not because interesting, but because needed to explain humanistic facts.
6. It should be modified by local conditions—teacher, facilities, time, etc. Hence, cut and dried rules are difficult, and uniform exercises in a number of schools out of the question.
7. Care should be taken to have all the exercises good. Usually a notebook or a course has some really good practical geography in it; but, too often a large part of the work is very irrelevant.

Good and Bad Exercises.

The ingenious, well-trained teacher will be able to devise many suitable exercises; those less trained or less ingenious, indeed all for that matter, may select from laboratory manuals, exercises

which they can use. No teacher should follow a manual through. I cannot here give in detail work which should be followed out, but I should like to call attention to a few types of good and bad exercises.

The picture book mentioned above was bad for geography but good for manual training. If the pictures had been grouped and labeled with notes calling attention to the physical features depicted and setting forth the human adjustments to the physical conditions, or the difficulties and obstacles met by culture as shown in the picture, it would have been a profitable series of exercises. All work, however, should not be of the same kind.

Here is another type that, so far as I can see, has no particular profit in performance. It is the third in a series found in a laboratory manual in my library.

"Old Volcanic Mountains. Volcanic Necks.

"Mt. Taylor Sheet, N. Mex.

"1. Describe Cabezon Peak as regards, (a) height above surrounding country; (b) slope; (c) form; (d) diameter at base.

"2. Make a profile along a line from the summit, extending eastward just over the top of the letter C to the 6,000-foot contour line, and westward to the same line. Take the elevations at the ends of the line, at the summit, and at the 6,400-ft. and 7,000-ft. lines. Draw this line one-half inch from the bottom of the paper.

"3. Make a written comparison of this and the other two profiles and paste the paper in your notebook.

"4. See Figures 8 and 9 in Physiographic Types Folio 2."

In this exercise there is nothing humanistic, the mountain is unknown and in a region whose climate makes it of but little human interest. Morever this profile is the twenty-second one called for in the book and we are not beyond the thirty-eighth page.

In another book I find exercises covering these topics from the physical and chemical side—the gyroscope, specific gravity, expansion by heat, humidity, combustion, magnetism. They have their physiographic and humanistic relations but these were not uncovered in the manual.

I find an exercise set apart to study veins in a piece of granite, another for the study of a series of minerals as follows: Pyrite, magnetite, hematite, limonite, cuprite, chalcopyrite, malachite, azurite, galenite, selenite, halite, calcite, asbestos, and gold. I

find on one page excursions as follows, "if possible a mine, a mint, a smelter, a foundry, a shot tower, and a salt works."

Perhaps it is impossible in some localities to find better working materials for the geography class than these, but I believe most teachers can find something more serviceable. This is an illustration of the substituting of geology for physiography or geography; a substitution or confusion as common in secondary schools as in colleges and universities.

FURTHER SUGGESTIONS.

I have been indulging in a little destructive criticism, an easy and sometimes rather profitless thing. I want to mention some types of exercises which I believe can be used to good advantage. The order is not significant.

Regional studies. (*a*) Niagara Falls and Vicinity. Illustrates the scenic value of falls and gorges and the economic importance of falls as a source of power; shows the condition attending one waterfall, and a long series of adjustments to these conditions.

(*b*) The home vicinity map can be used to find known places and see how they are recorded on the map. Note the adjustments between culture and contour and the difficulties that are in the way of things humanistic in the vicinity.

(*c*) A bit of coastal plain selected from New Jersey, Georgia, or Maryland can be used to illustrate, not only the plain but how the people, the roads, industries, towns and all, fit down upon the plain.

(*d*) A big city like New York as shown on the topographic map and the coast survey chart presents a host of physical features nearly all of which play directly into the economy of the city and its interests. Many small places will serve equally well.

River studies. (*a*) One exercise might plot on an outline map the great drainage basins of the continent; and then a rainfall map of the continent might be introduced and questions put to show why the Ohio River has worse floods than the Missouri River? Why the Humboldt does not reach the sea, etc.? (*b*) A temperature map of the continent could be used with the river map to impress the futility of trying to develop river commerce on the Mackenzie and Lena Rivers. A relief map of the continent could play into this study to locate streams that would be serviceable for power, for irrigation, for navigation, etc.

Under the heading, *The Atmosphere*, quite a series of observations on temperature, cloudiness, precipitation, and wind direction should be made. The weather map should be studied and the

observations correlated with the cyclones and anticyclones in order to develop the principles of forecasting; but the study should not stop until the rainfall and temperature changes incident to the passage of a cyclone have been made significant in the daily weather, in shipping, crops, and harvesting.

The topic *Harbors* centralizes a lot of excellent geographic material. Study two or three to see the physiographic features and the advantages, disadvantages, and adjustments presented. See what improvement and care are needed and try to discover why. Let the human relations call out the physical elements.

The correlation of related elements which have been separately mapped constitutes a most fruitful series of exercises. Use a good physical atlas and a good commercial atlas (Longman's will serve for the physical and Bartholomew's, Macmillan, for the commercial).

Set over against each other the relief map and the rainfall map of a continent or country and by judicious questions bring out the relations. Try India, the United States, England, or Italy. Then try to find why it doesn't rain similarly on both sides of a mountain, or snow an equal amount in two places of the same latitude. This will call for the wind map, then possibly the temperature and pressure maps. Discuss only typical places.

Follow this kind of work with correlations between a rainfall map and a map of forests or a population map. Then introduce the relief map and try to find which is more significant in the distribution of forests, rainfall, or relief. Do the same for distribution of people.

With a map of deserts correlate one of rainfall. Seek a reason for the absence of rain and lead to the relief map and the wind map and the map of land and water. Ask questions on specific regions until the facts lead to the principles. Careful observation, accurate records, and logical deductions should be made in every exercise. These are three things in which we are all of us, all too short, yet they are essential to any successful career. Facts of the science are here required along with the inculcation of right habits; and the habits formed are such as constitute the intellectual equipment of every successful business man, housewife, traveler, or mature scholar. The laboratory work not only illustrates the broad principles discussed in the class room but furnishes experience in expression. How well does a person know a thing if he cannot tell it?

The materials necessary for such laboratory work as this are

widely scattered, but in no case prohibitively so; nor are they expensive. Topographic maps of various regions can be had at five cents apiece (in quantities, three cents) of the director of the U. S. Geologic Survey, Washington, D. C. The Coast Survey harbor charts run from twenty-five to fifty cents and can be purchased of the U. S. Coast and Geodetic Survey, Washington. Weather maps can be obtained daily from the nearest weather bureau station. Rainfall maps and continental relief are in the physical atlas; population, crop, and timber maps are in the commercial atlas. Many good maps of these data can be found in the atlas volume of the census reports.

DETERMINATION OF POLE STRENGTH OF MAGNETS AND THE EARTH'S HORIZONTAL COMPONENT.

By H. W. Harmon,
Grove City College.

In the March, 1903, School Science and Mathematics Professor H. D. Stearns gave an extremely clear and simple method of determining pole strengths, and the strength of the earth's field. With the apparatus shown in the cut we are finding the method a practical and surprisingly accurate one. The following is a brief description of the apparatus and theory of the method: A magnetized knitting needle m_1 m, is placed in a brass or tinfoil stirrup, supported by the silk fiber F and placed in the N-S groove, accurately balanced and centered, and the apparatus is then turned until the N-S meridian line is parallel to the needle, as it swings freely. If, now, the needle is lifted out and placed in the E-W groove with its N pole pointing west, the needle will be urged to return to its former position by the action of the earth's horizontal component (H) acting on both of its poles (m_1) with a combined force:

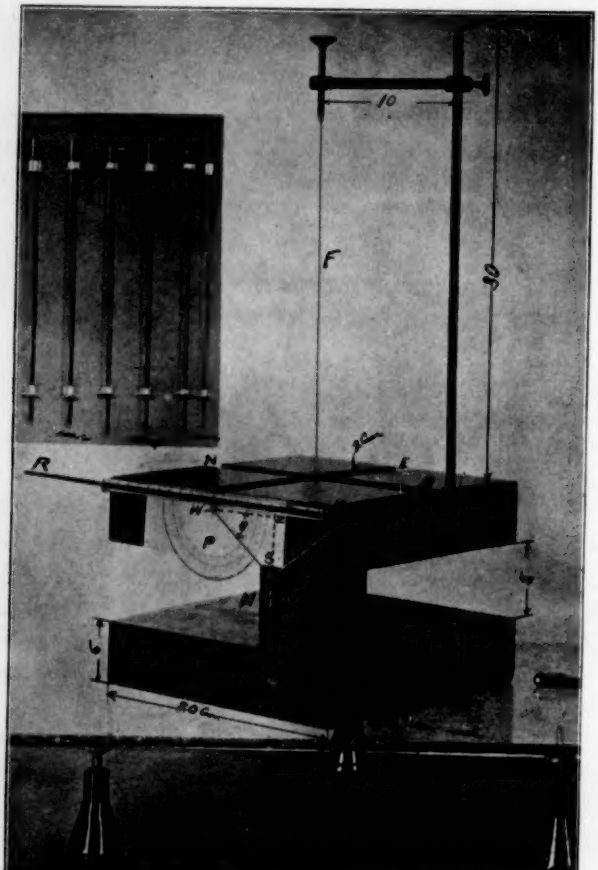
$$F=2m_1 H \text{ ......No. 1}$$

To neutralize this tendency slip the looped end of the silk fiber (WSK) over the N pole of the magnet which projects through the opening in the center of the protractor and slide the rod (R) right or left until the horizontal component (WZ) of the 10 milligram weight (M) holds the magnet in equilibrium. This equals:

$$F=\frac{\frac{1}{2}M}{\text{Tan } a} \text{ ......No. 2.}[1]$$

[1]M must be reduced to dynes.

where (a) is the angle of the fiber below the horizontal and is read off in degrees or natural tangents from the protractor. M is a 10 milligram weight hung from the middle point of the **fiber.**



If now the first needle (m_1, m_1) be replaced by another needle (m_2. m_2) as before in the (E-W) direction, its tendency to return will be different and equal to:

$$F_1 = 2m_2H \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{No. 3}$$

If this tendency to return (N-S) be neutralized by placing the N pole of the first needle (m_1, m_1) with its axis east and west at a suitable distance (d) to the left of (W) and this distance measured, we will have:

$$F_1 = \frac{m_1 m_2}{d^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{No. 4}$$

by their equality in No. 3 and No. 4

$$\frac{m_1 m_2}{d^2} = 2m_2\text{H} \text{ or}$$

m_2 canceling out

$$\text{H} = \frac{m_1}{2d^2} \text{ .... No. 5}$$

also by their equality in No. 1 and No. 2

$$2m_1\text{H} = \frac{\frac{1}{2}\text{M}}{\text{Tan } a} = \text{F or}$$

$$\text{H} = \frac{\text{F}}{2m_1} \text{ .... No. 6}$$

Now by combining No. 5 and No. 6 and solving for m_1

$$m_1 = d\sqrt{\text{F}} \text{ .... No. 7}$$

H is now computed by the use of either No. 5 or No. 6.

We are using three different sizes of needles, large, medium, and fine; as shown in cut they are mounted on a cardboard holder to avoid mixing them.

Trial	Magnet Combinations	Angle		Restoring Force F	Polar Distance d	Pole Strength m	Earth's Horizontal Component		Error
		a	Tangent				Observed H	Correct H′	
1	m_1 & m_2	35°	.7002	7.00 dynes	7.5 cm.	19.82	.1768 dynes	.184	.0072
2	m_2 & m_1	33.5°	.6619	7.41 "	7.6	20.70	.1791 "	Dynes "	.0049
3	m_3 & m_4	48°	1.1106	4.41 "	5.85	12.27	.1795 "	"	.0045
4	m_4 & m_3	51°	1.2349	3.962 "	5.8	11.53	.1718 "	"	.0122
5	m_5 & m_6	66°	2.2460	2.262 "	4.0	6.02	.1880 "	"	.004
6	m_6 & m_5	65°	2.1445	2.283 "	4.05	6.12	.1866 "	"	.0026
7	m_1 & m_3	35°	.7002	7.00 "	7.7	20.3	.1723 "	"	.0147
8	m_3 & m_1	48°	1.1106	4.41 "	5.9	12.40	.1772 "	"	.0068
9	m_2 & m_5	33.5°	.6619	7.41 "	7.8	21.23	.1747 "	"	.0093
10	m_5 & m_2	66°	2.2460	2.262 "	3.95	5.935	.1882 "	"	.0042
						AVERAGE =	.1798 "	"	.0031

By referring to the data table, the pole strengths of these vary from about 6 to 21 unit poles. With the three pairs of needles a large number of combinations for making different trials are possible.

Examination of the (H) and (m) columns in the data table will show the accuracy of the apparatus; pole strengths being determined to within ½ unit pole and earth's field to within .01 of a dyne or about .01 milligram.

The experiment gives us a realizing sense of the value of a unit pole, and that the earths' field urging a compass needle into the (N-S) direction is less than one fifth of a dyne. From this latter we can infer that a compass needle must be mounted on a good point else this feeble force will not be able to overcome the friction on it.

This experiment is not beyond the good high school student taking physics, for he has the definitions of unit pole and unit field and from his knowledge of resolution of forces into components the diagraming of the triangle WZS to scale gives him the component WZ, which is equal to (F); or if they understand the meaning of tangent, the natural tangents can be read off directly from the protractor, or looked up.

The dimensions of the apparatus are given in the cut. The leveling screws may be omitted. The grooves, cut 2 cms. square, are for the purpose of avoiding air currents.

AN EXPERIMENT IN ORGANIZING A COURSE IN GENERAL SCIENCE.

By E. D. Huntington.

An investigation of what science matter, is essential in the first year of the high school was made by the writer during 1910-1911. Theoretical investigation was paralleled by experimentation with a first year class in a rural high school, extending over a period of nearly six months. The results of these investigations are briefly summarized below. In addition, a further investigation was carried on as a special problem in connection with a class in the University of Chicago.

It being generally conceded that there should be some science course at this point, the vital question becomes what science or sciences should be selected. Botany, zoölogy, physical geography, physics, and of late agriculture, have all been tried, and usually have proved unsatisfactory. Among the reasons assigned for their failures, the following seem the most pertinent: The first two are too specialized and formal, and if presented successfully at this point must be largely handled in an extremely elementary and superficial way; the third has become the specialized and technical physiography, which precludes its most effective use in the first year of the high school; physics as a differentiated science is too technical for first year stu-

dents; agriculture, if studied as a science, requires a previous knowledge of the elemental sciences in which the pupil is wholly lacking. The pupil's training in science in the grades has been markedly informal, consisting mostly of biological nature study, if any at all; he makes his first formal acquaintance with science at this point, and for this reason it seems advisable not to confine his efforts to some specialized branch of scientific inquiry. In his first formal course in science, the pupil needs to acquire such scientific training and knowledge as will serve as tools in his further science studies, and as will tend to acquaint him with the commonplace things of his daily environment. The fundamental facts and theories of science, and not some specialized branch of science, should constitute the subject matter. The sciences that are essentially fundamental are physics and chemistry, since they are employed as tools by all the other sciences—an intelligent study of plant or animal physiology (the point of vital interest in botany or zoölogy) is absolutely dependent on a knowledge of the elements of physics and chemistry; soil fertility, one of the most universally recognized fundamentals of agriculture, is a function of chemical reaction and physical change, etc. Without a considerable knowledge of the fundamental sciences, the essentials of these other sciences are memorized and not comprehended.

Most of the common phenomena of daily life are physical and chemical; common instances are electric appliances, railway train, water works, light and heat, combustion, oxidation, respiration, decay and fermentation. Interest in the biological subjects is largely due to their applications of chemical and physical principles; for instance our interest in bacteria is almost wholly due to the chemical effects they produce. And a proper study of the elements of physics and chemistry will naturally lead the pupil's interest into those general biological relations in which our vital interests lie.

Physics and chemistry certainly could not be successfully presented in their formal aspects in the first year of the high school. The subject matter as selected, arranged and presented in the standard texts must be largely disregarded; the organization of the subject matter should not be a process of elimination, but rather one of selection. Subject matter so chosen can be conveniently arranged as a continuous unity, each lesson being an outgrowth of the preceding. In the arrangement of the subject matter there needs be kept in mind that what is log-

ical to the adult is not necessarily so to the pupil—that the arrangement and presentation while guided by the adult should appeal to the pupil's logic. The inductive presentation seems to secure the best results, the child discovering the facts and theories under the guidance of the instructor, definitions and laws being discovered—not memorized—before the class uses them in further work. The inductive method necessitates the presentation of the *new* in terms of the *old;* the recitation is begun with a discussion of the *known,* and is so guided by the teacher that the discussion leads to the *unknown.* The pupil is led to define new situations rather than to memorize formal statements. He himself discovers or is led to discover the problem, which gives him a keen interest in the solution of it. In such presentation, the child perceives the relations between things, and hence associates his ideas—the essential factor in memory. To quote from Herbart, "definitions have genuine value only for him in whom they have grown up."

Experiments can effectively be presented as demonstrations, and facts and theories developed from observations at the time the demonstration is made. The pupil is not yet old enough to be entrusted always with the performance of the experiments required in such a course, but he can acquire an acquaintance with apparatus and manipulations by assisting the instructor in the demonstrations and by especial exercises. Furthermore in many schools there is not sufficient laboratory facilities for individual experimentation with the large number of experiments requisite for this course.

The course outlined below, which was worked out in conjunction with Mr. E. P. Reynolds of the Platteville (Wis.) State Normal, presents such subject matter as experience seemed to indicate could be efficiently adapted to the first year of the high school; in its organization, the aim has been to make it appeal to the child's logic, and at the same time present the logical fundamentals of science.

Definitions have genuine value only for him in whom they have grown up.—*Herbart.*

I. ATMOSPHERE.

1. *Air is matter.*

a. Occupies space.

Bicycle tire, paper bag, football, inverted tumbler, etc.

b. Has weight.

Magdeburg hemispheres.

c. Air in motion (wind) has energy (exerts force).

2. *Atmosphere exerts pressure—due to the weight of air.*
   a. Loading a wagon—analogous to the atmosphere.
   b. Pressure in all directions.
      Analogies, tumbler of water, can crushing.
   c. Pressure acting on a free surface.
      Inverted jar of water, rise of water in exhausted tube, lemonade straw.
   d. Pneumatic appliances.
      Lift pump, siphon, barometer and altitude, vacuum cleaner, etc.
3. *Expansion and diffusibility.*
   a. Demonstration—air pump; short barometer—toy balloon—two bottles (under bell jar).
      Partial vacuum.
   b. Compression and expansion.
      Bicycle pump, air compressor, air brake, bellows, mechanism of breathing.
   c. Diffusion.
      Porous cup, odors, etc.
      Molecular theory.
   d. Molecular theory—compression and expansion and pressure changes; heat effects of same.
   e. Heating and cooling of air.
      Expansion and contraction, weight, molecular explanation.
      Hot-air furnace, draft of fire, winds—land and sea breezes, mechanism of ventilation.

II. Familiar Chemical Reactions.
1. *Combustion.*
   a. Burning depends on air.
      Drafts and damper, tumbler inverted over lighted candle, "smothering" fire, mechanism of chemical fire extinguishers.
   b. Air is a mixture of O and N.
      Phosphorus burning.
   c. Kindling point.
      Lighting a match, kindling a fire.
2. *Oxidation.*
   a. Rust and other oxides of metals, painting, relation of oxidation and combustion, spontaneous combustion.
   b. Oxidation in the tissues, products.
   c. Decay and fermentation—bacteria and yeasts.
3. *Composition of wood and products of combustion.*
   a. Destructive distillation, products of burning H and C, superficial properties of O, H, C, ash and CO_2.
   b. Phenomena of a burning splinter, smoke, soot, etc.
4. *Oxygen-Carbon Cycle.*
   a. Decomposition of starch and sugar.
   b. Photosynthesis.
      Water plant experiment.
   c. Cycle in aquarium, in atmosphere.

III. Further Study of Chemical Reactions.
1. *Decomposition of water.*
   a. Review of combustion and oxidation, formulæ of products.

2. *O, H, C and CO_2.*
   a. Intensive study of properties.
3. *Acids and salts—solution.*
   a. Common fruit acids and vinegar.
   b. H_2SO_4, HCl, HNO^3.
      Reactions with metals, generation of gases, heat phenomena compared with combustion, formation of salts, equation, atomic theory.
   c. Manufacture of H_2SO_4 and HCl.
   d. Soil.
      Fertility and crops, fertilizers, nitrifying bacteria.
4. *Bases.*
   a. Lye, lime, ammonia—neutralization and salts (especially NaCl).
   b. Production, uses.
   c. Soap—manufacture, hard water.
5. *Na, Cl.*
   Properties studied as illustrative of extremely active elements.
6. *Generation of CO_2.*
   a. Baking powder.
   b. Fire-extinguishers.
   c. Limestone.
7. *Explosions.*

IV. Aqueous Phenomena—Heat.

1. *Evaporation.*
   a. Factors affecting—molecular theory; relation of humidity and barometer.
   b. Cooling effect and refrigeration.
2. *Condensation.*
   a. Dew, fog, clouds, rain, etc.
3. *Expansion and contraction.*
   a. Due to heat, hot water heating system.
   b. Solids.
4. *Freezing, melting, states of matter—heat.*
5. *Steam.*
   a. Boiler, heating system, engine.
6. *Aqueous cycle.*
   a. Evaporation, winds, rainfall, rivers, water-power, trees, etc.

V. Electricity and Magnetism.

1. *Primary cells.*
   a. Electricity produced by chemical action.
2. *Chemical effects of current.*
   a. Electroplating, storage battery, decomposition of water and NaCl.
3. *Heat effects.*
   a. Electric lights, stoves, fuses.
4. *Magnetic effects.*
   a. Electro magnet, telegraph, bell, fire alarm, telephone.
   b. Motor and dynamo.
   c. Induction and transformer.
5. *Permanent magnets.*
   a. Compass and terrestrial magnetism, poles.
6. *Lightning.*

VI. SOUND.
  1. *Nature.*
    a. Origin, transmission, speed, echo, etc.
  2. *Applications.*
    a. Megaphone, speaking tube, telephone, phonograph.
    b. Stringed and wind instruments.
    c. Voice and hearing.

VII. LIGHT.
  1. *Nature.*
    a. Origin and relation to heat, transmission, speed.
  2. *Applications.*
    a. Mirrors and images, pin-hole camera, lenses, camera, stereopticon, search-light.
    b. Sight.

VIII. INDUSTRIAL AND HYGIENIC STUDIES.
  1. *Waterworks.*
  2. *Sewerage Systems and Public Health.*
  3. *Ventilation.*
  4. *Production of Coal Gas.*
  5. *Electric Power Plants, Electric Railways, etc.*
  6. *Meters.*
  7. *Problems in Preparation of Foods.*
  8. *Photography and Allied Processes.*
  9. *Steam Railroad Train.*

In organizing the preceding outline, the subject matter has been primarily grouped about a study of the atmosphere. The young pupil is not easily interested in matter, energy and space, as such; but he is already interested in atmospheric phenomena, from a study of which he gains concepts of matter, energy, space, and the other essential points of physics. Burning and oxidation form a connection to the study of chemical reactions, which in turn lead to a study of electricity, as appears in the outline.

At first glance, it seems a long step from the "heating and cooling of air" to "combustion," but to the pupil there is a close connection; for he is interested in the atmosphere and not in physical and chemical classifications. Likewise, other apparent gaps between topics in the outline are not gaps to the child.

The experiments presented cannot be too simple and concrete. The method which the writer found very efficient can best be expressed by stating the actual steps in one of the more complicated experiments. To answer questions on the origin and composition of acids, and to demonstrate the possibilities of the chemical reaction, the manufacture of sulphuric acid from simple materials was undertaken in class. Sulphur was burned

producing sulphur dioxide which the class from its previous work recognized as a compound of sulphur and oxygen; its formula was stated by the instructor. The gas was then bubbled through distilled water until a saturated solution was obtained, which was found to have the characteristic properties of acids, although no apparent reaction with metals was obtained. That it was not sulphuric acid was evident from its odor; the children completed the equation for the reaction ($SO_2+H_2O=H_2SO_3$), and were told that the acid was called sulphurous acid. Air was bubbled through it for a few minutes every day for ten days, by which time its odor had disappeared. It was now found to react noticeably with zinc, which led the children to conclude that it had changed—that it had "oxidized." The equation $2H_2SO_3+O_2=2H_2SO_4$ was now developed. Commercial sulphuric acid was then placed in two test tubes and "home-made" acid in two others, each being properly labeled. Reactions were then obtained with copper and zinc, and the salts formed by the two acids with the same metal were apparently the same.

The experiment and its summary were very significant to the class. They had started with the familiar substances, sulphur, air, water and copper, and by combining them in what was to them a simple way had produced a new substance, copper sulphate, which was very different from any of the substances used. Such an experiment makes the chemical reaction a concrete and comprehensible thing; this experiment suggests in detail the manner in which the other topics in the outline were handled.

PRACTICAL PHYSICS IN PRIVATE SCHOOLS FOR GIRLS.

By Elizabeth Duval Littell.

I have taught elementary biology for several years in a large private school for girls in one of our large cities and each year the utter ignorance of the children of the rich about everyday phenomena comes to me with a shock. Girls of sixteen—with well-developed taste in literature, able to read the classics at sight, with some real grasp of history, intelligent and logical in mathematics—are helpless before the simplest problem of natural science, if indeed they go so far as to recognize its existence and claim to solution. Pupils almost always say, when I first ask them about it, that the drops of water on the outside of an ice pitcher have leaked through. They won't bring their minds to bear on the question. Perhaps boys of the same class in life are not so uninquiring—they have more real experiences in their lives—but the girls' education is terribly one-sided. I am convinced that the difference is due solely to education, and not to instinct, as commonly supposed. The first toy given to a boy is an engine, and from then on he is expected to take an interest in machinery of all sorts and to understand things. A girl's first toy is a doll, with no greater intricacies than blinking eyes or clothes that come off and on. Later training emphasizes these extremes, developing the boy and stultifying the girl. In my own experience I have found that when once accustomed to the scientific point of views girls are just as responsive and interested as boys. I recall a large class of little girls watching the making of a barometer. The jar of mercury broke and the delicious drops rained on the table and floor. I expected a stampede, but the only result was distress for the interruption and a hurried sweeping up of the mercury that the delay might be as short as possible. It seems only fair to give girls capable of such absorption a better chance. In the experimental work connected with the botany and zoölogy I have found them keen, logical, and sometimes quite remarkable in their penetration. Girls of rich parents are especially at a disadvantage owing to the conditions of their lives. If they were less "well off" they would of necessity gain some practical elementary ideas of science. They would be obliged to make fires, cook, wash clothes, mend things when out of order. The children of the rich never go into the kitchen. When something doesn't work they "send for the man to fix it." Inventions are simply for their convenience—there is no need

that they should be understood. They are overcivilized. It is not their fault that they have shut their minds to these things. They are not at all stupid, they are ready and willing, but they, more than any other class of children, will not respond unless they are *interested.*

School must supply for these girls what their home lives lack. This can best be done by a course in what might be called applied physics. It would deal with the everyday phenomena of their life in the city. It must stir their curiosity, give them problem after problem to solve, put common sense side by side with the uncommon sense they already have, and develop power and independence.

In the school I speak of there is at present no course in physics. The head master has a wholesome dread of college preparatory physics. He thinks it better to know less about these things than to feel bored by them. For this I am deeply thankful, for at least the ground is clear. For several years I have been begging to be allowed to try a course of common sense physics. The very name is alarming. All kinds of objections have been offered, the chief being that it is too dull and abstruse and takes too complicated equipment. I have protested that it need not be dull or unrelated to life and I have positively declined to have any elaborate apparatus, trying to make them understand that we have all the material we want lying ready at hand, especially in the school building itself. Now I have permission to disregard the college entrance requirements and try it out on these lines next year.

Since I believe that the laws of physics will be more real through their applications than as abstractions, I shall choose the following subjects for the course: Applications of electromagnetism, ventilation, heating, lighting, water supply, wireless telegraphy. These subjects are not chosen at random. It will be seen that they cover practically all the ground of physics and that an understanding of them will make children begin to feel intelligently at home in their complex city surroundings. In each subject I shall work always with reference to the whole, taking up details only as means to an end, explaining instruments broadly and incidentally as they are needed, not making them ends in themselves, and omitting measurements and mathematics. There will be a great variety of simple experiments and any number of illustrations drawn from everyday experience, so that familiar things will stand out in their relation to the subject in hand.

It will be well to begin the course with electricity and, indeed, spend a large part of the year on it. It is more interesting than anything else and so will give the best grip on the class. The dynamo will be the first thing to study. In its simplest form—a coil of wire with an iron core, a magnet and motion of one part with reference to the other—a dynamo presents no difficulties. From this to the dynamo as the children must see it in a power-house, is a step great only in degree. The dynamo as motor is mere matter of experience. The class can find out the various uses of motors, especially investigating street cars and the different methods of transmission of electric energy. They will learn to install and repair bells, to set up and operate telegraph and telephone lines. The different kinds of batteries and their general principles will be discovered incidentally through use. This is true, also, of those usually troublesome things, galvanometers, voltmeters, ammeters. Questions of resistance, the best arrangements of cells, etc., will have to be solved for practical reasons, and so make permanent impression. Members of the class will discover and report on other applications of electromagnetism like these outside of the school and a list will be kept. They can work individually or in small groups and so cover this great field more rapidly.

The use of the motors in the school basement will lead the way to the next subject, ventilation. This is a hobby of their parents and is under daily and ignorant discussion at home. It will be satisfactory to bring it into the realm of physics, where it belongs, and show that it must be approached from a scientific standpoint. The children will discuss, with demonstrations, the constituents of the atmosphere, its vitiation, renewal, the amount of fresh air required and possible methods of getting it. They will investigate the system in the school building, make tests of its efficacy, and compare it with other systems known to them elsewhere. Incidentally such subjects as evaporation and humidity, the different behavior of hot and cold air, the use and general principles of thermometers, thermostats, anemometers, and humidostats will arise and can be cleared up by simple experiments.

Heating of buildings will come next, with explanatory experiments as to the nature and source of heat, its propagation and effects. There is an unusually large opportunity to draw on personal experience in these discussions. The class will study the school heating arrangements and then each child will report on the way her own house is heated, the various systems to be as-

sorted into groups in class and comparisons made with regard to efficiency and cost. If there is time enough some fascinating work can be done with thermos bottles, fireless cookers, and applications of electric heating.

Then will come a demand to know about house and street lighting, from candle to arc lamp. They should be able to know what is wrong if the lights are poor and in all simple cases be able to set it right. They should understand how meters work, the relative advantages of the different kinds of lighting, and they will end this part of the work by putting into the schoolroom a miniature system of electric lights.

Last summer's alarm about the water supply made people who had hitherto thought of city water as an unfailing gift from heaven realize that it was their responsibility to prevent waste. These girls who are to be housekeepers can be made now to understand their obligations to the public. The simple mechanisms that control the water in each house are easily understood. Why should a plumber be sent for to shut off the water or when a faucet needs a new washer?

In the spring I want to have a wireless telegraphy outfit on the roof, set up and worked by the children.

It is with some trepidation that I say that this course is a one year course. Each heading offers material enough for a year, but it can be taught in the time assigned by the relentless elimination of unimportant details, by considering each thing from the standpoint of what it *does*. It is customary, for instance, in physics courses to spend weeks on thermometry, the dull and useless detection and correction of error. In this course an intelligent understanding of the working of a thermometer is all that is wanted and it can be got in ten minutes by simply using a thermometer with some incidental talk about the principles of it. I want to cultivate activity not accuracy.

It will be noticed that I have made no place, in the course, for mechanics as such. My reason is that it will make its own place to a large extent incidentally, and that only in so far as the principles of mechanics are discovered at the time of need are they the permanent property of the mind.

Much can be done to humanize the subject all the way along. The stories of physicists and their discoveries are often thrilling and too little is heard about them.

A brief outline of the discoveries in radioactivity would fittingly

close the year's work with some discussions of the theories about electric energy.

In conclusion, I want to say a word about the teacher's equipment for such a course. I cannot help feeling with all humility that perhaps the teacher untrained in the technicalities of physics, but with a vast interest in the workings of things, is best equipped for this kind of work. She is not hampered by tradition, she sees the pupils' difficulties from their own level, not from a height, and she wants what they unconsciously want—a common sense explanation of everyday phenomena.

SOME ROCK ANALYSES.

By Nicholas Knight,
Cornell College.

1. A specimen from Kenilworth Castle.

The castle has long been in ruins, but it is among the most interesting spots in all England. Scott has immortalized the place in his famous novel, the scene of which is laid during the reign of Queen Elizabeth, when the castle was owned by Lord Dudley, the Earl of Leicester. The Earl entertained the Queen two weeks at an expense of five thousand dollars a day, which was an almost fabulous sum in that period. The rock is a beautiful and durable red sandstone, and a private communication from Sir Archibald Geike conveys the information that it belongs to the new red sandstone. The analysis was made by John W. Liddle as follows:

SiO_2	86.95%
Fe_2O_3	3.45%
Al_2O_3	6.31%
CaO	2.16%
MgO	0.88%
Total	99.75%

The iron oxide is the cause of the red color. The iron, alumina, calcium, and magnesia doubtless serve to cement the particles of sand into a hard, durable rock.

2. Soil from the yard of Westminster Abbey.

So many people surged around the sacred edifice in connection with the coronation ceremonies of 1911 that the grass on the lawn was trodden down and killed. On August 8 of that year men were spading up the ground preparatory to reseeding. A

specimen of the earth was taken for the analysis which was made by Irwin P. West. It probably contains no "sacred dust," as this is carefully preserved on the inside of the great cathedral, and there is more of it than in any similar enclosure on earth. The analysis was as follows:

SiO_2	71.71%
Fe_2O_3	7.40%
Al_2O_3	7.60%
CaO	2.40%
MgO	1.79%
CO_2	2.46%
K_2O	0.41%
Na_2O	1.85%
TiO_2	0.21%
P_2O_5	0.56%
H_2O	1.03%
N	0.60%
Total	100.55%

3. Sandstone from Lucerne.

One of the most imposing monuments in Europe is the one to the Swiss soldiers who fell in defense of King Louis XVI of France. It is the work of the great Danish sculptor, Thorwaldsen. The monument is a huge lion, twenty-eight feet in length, carved in the sandstone rock, which is light gray in color. The analysis was made by W. B. Armstrong, as follows:

SiO_2	56.72%
Fe_2O_3	2.29%
Al_2O_3	14.34%
CaO	13.83%
MgO	2.97%
CO_2	10.15%
Total	100.30%

As will be noticed, the rock contains a considerable admixture of limestone.

4. The Rock of Gibraltar.

This world renowned rock rises above the sea to the height of 1,300-1,400 feet. It is limestone and there are two distinct varieties! A stalactitic formation, which in many places forms a crust on the outside of the ordinary limestone, which is the main portion of the rock.

a. The stalactitic formation. Analyzed by W. E. Morling.

It must have been dissolved in water containing CO_2, and again deposited from the solution:

$CaCO_3$	96.12%
$MgCO_3$	2.75%
SiO_2	0.20%
Al_2O_3	0.64%
Fe_2O_3	0.00
Total	99.71%

The rock is hard and compact, fine-grained in texture, and made into various souvenirs to sell to tourists. It is rather an unusually pure limestone.

b. The ordinary limestone analyzed by Forest Edwards:

$CaCO_3$	83.87%
$MgCO_3$	8.14%
Al_2O_3	4.07%
Fe_2O_3	2.81%
SiO_2	0.39%
Total	99.28%

5. Rock from the Simplon Tunnel.

This is in general a fine specimen of granite. It is used for building purposes and also a road material. Some of the largest granite columns in the world came out of the tunnel and are used to support the great arches in "St. Paul's Outside the Walls," one of the four jubilee churches of Rome. The analysis was made by E. W. Tallman and resulted as follows:

SiO_2	70.69%
TiO_2	0.52%
P_2O_5	2.07%
MoS_2	0.17%
Al_2O_3	15.13%
Fe_2O_3	2.21%
CaO	1.25%
MgO	0.45%
K_2O	2.26%
Na_2O	2.46%
CO_2	2.50%
Total	99.68%

GEMS THAT RESEMBLE THE DIAMOND.[1]

By F. B. Wade.
Shortridge High School, Indianapolis.

In spite of many seductive advertisements there is no gem that *"looks just like a diamond."* Nor should we expect to find one, for, while two different substances may have a number of properties in common yet a study of *all* the properties of each will show many which differ. Still there are a number of gems which possess to a considerable degree some of the properties of the diamond and when well cut these gems can deceive and frequently have deceived those not expert in the determination of precious stones.

In times past such gems have even passed current as diamonds before the scrutiny of experts, for until the general spread of science, such tests as those of specific gravity, refraction, etc., were not applied, and many colorless zircons, topazes, and sapphires probably passed as rather inferior diamonds. It is even claimed that the Braganza, a mammoth uncut gem among the Portuguese crown jewels, is merely a fine specimen of colorless Brazilian topaz, yet it has been listed for years among the world's greatest diamonds.

Among the gems which may be regarded as so closely resembling diamond as to be likely to deceive the inexpert, I will list and briefly discuss the following:

First, the colorless or pale zircon, sometimes called in the trade, the jargoon:

Second, the colorless sapphire;

Third, the colorless true topaz;

Fourth, the colorless beryl;

Fifth, colorless phenacite;

Sixth, colorless quartz.

These and a few other and rarer colorless gems constitute the list of gems that resemble the diamond. I may say at this point that none of them resembles the diamond to the casual glance so closely as does the very brilliant lead glass used in making the so-called "paste" or "strass" imitations so widely advertised and sold under various fictitious titles in many cities. This artificial material possesses a very high refractive index and is capable of separating the various colors of the spectrum so

[1]Reprinted from the Journal of Industrial and Engineering Chemistry Vol. 4, No. 7. July, 1911.

widely that it affords a brilliancy and "play" of colors that nothing but the diamond can equal. It is, however, deficient in hardness, being easily attacked by a file and consequently it does not long resist dulling and scratching from wear and hence does not hold its brilliancy. It is also easily attacked chemically by a number of things, with which it is likely to come in contact in wear and thus be still further dulled. In many of the imitation diamonds the tendency to scratch is partially prevented by using a thin slice of some hard gem material for the upper surface, making in other words a so-called "diamond doublet." This artificial gem has no real diamond about it, of course, although formerly a few real diamond doublets were made in which the upper half of the stone was made of real diamond and lower half of some less costly white gem, the two being joined at the girdle by means of gum mastic or other transparent cement. The modern diamond doublet usually has an upper surface made of a very thin slice of garnet, covering usually only the table, as the part subject to greatest wear. The garnet used is pale in color and so thin is the slice that hardly any color is visible. The remainder of the "stone" is entirely of lead glass. Some of these "works of art" are certainly very beautiful and at a reasonable distance they would probably puzzle an expert.

While none of the genuine gems I have listed quite approaches the "paste diamond" in play of colors, many of them are nearly as brilliant in the lively play of white light which they afford when cut in a manner suited to such material, which cutting, by the way, should not be just like that most suited to the diamond.

In regard to the order of precedence among them, I should put the colorless zircon first. This gem possesses adamantine luster in a high degree, that is, the amount of light reflected from its *top* surfaces, when properly inclined to the light approaches closely to the amount reflected by a genuine diamond surface. This effect must not be confused with the brilliancy of the flashes of light reflected from the *interior rear* surfaces of the stone. That is another matter. This adamantine luster gives what the French call éclat to the zircon. It is snappy, cold, and glittering in its luster. So closely does it resemble diamond in this respect that I was able to deceive a diamond cutter in one of the best establishments in this country by a brown zircon which I wore in my scarf this summer. He referred to it as my "brown diamond," although he was not above four feet away and looking

squarely at it. Of course in a stone of positive color, no large amount of prismatic "play" is possible or expected, and so the lack of it in my brown zircon was not felt. The cutter would doubtless have detected the difference in a colorless zircon but one not so expert might not.

Of course, in hardness, in specific gravity, and in refraction, the zircon is not like the diamond. It is much softer, being only 7.5 as against 10 in hardness by Moh's scale; its specific gravity is 4.4—4.7, as against 3.5—3.6 for diamond; and it is doubly refracting while diamond is singly refracting. It could thus be readily distinguished by anyone who understood the application of the tests for the above properties.

After the zircon in order of excellency I would place the white sapphire. Its index of refraction is higher than that of any of the other gems in my list except the zircon, and its great hardness renders it capable of taking and holding a polish almost equal to that of the diamond. It does not possess the adamantine luster, however. Its luster is probably best defined as splendent. It exceeds the luster of glass and of the other gems in my list which have what is usually styled the vitreous luster. Both the zircon and sapphire when well cut and pure white show a faint "play" of colors and both give fine brilliancy in their reflections of white light. I have fooled many retail jewelers with a fine specimen of white sapphire which I have set in a ring. As in the case of zircon, so with the sapphire, a test of its hardness, specific gravity, and refraction will at once serve to distinguish it clearly from diamond. Its hardness is 9, its specific gravity 3.9—4.1, and it is doubly refracting.

Next to the zircon and sapphire I would place the white topaz. It gives a faint play of color, is hard enough to resist wear for years and takes an extremely high polish. Many so-called "white topazes" advertised by unscrupulous dealers are only lead glass, and many more are cut from the softer and cheaper rock crystal. I had one of the latter sent me recently under a guarantee that it was a genuine white topaz. It was a finely cut and very brilliant gem but it *was not real topaz.* I sent it back after a specific gravity test, which I recorded on the inside of the paper in which the gem was wrapped, saying that I was sorry but I couldn't use "that kind."

I have already referred to the Portuguese "Braganza" as probably a white topaz. The fact that the specific gravity of topaz is

very nearly that of diamond makes it a still more dangerous imitator, but its hardness of 8 and its double refraction serve to distinguish it.

The other colorless gems in my list, phenacite, beryl, and rock crystal very closely resemble each other and all give brilliant stones when properly cut. The phenacite and beryl are but slightly softer than topaz and would wear well. The rock crystal is the softest in my list, and while it will hold its brilliancy for some time it would dull in the course of a few years or even months if subjected to hard wear as a ring stone.

Aside from the peculiar interest which attaches to these colorless stones from the fact that they may be and doubtless many times in the past have been substituted for diamond either ignorantly or with purpose to deceive, there is, I believe, a worthy interest in them for what they really are and for the real beauty which they undoubtedly possess.

When men shall have learned to practice honesty as the best policy, it is to be hoped that these gems, which do truly somewhat resemble the diamond, but which resemble each other more, may come into their own and be appreciated and valued for their own beautiful qualities.

AN EXPERIMENT IN THE TEACHING OF PHYSICS.

By H. C. Krenerick,
North Division High School, Milwaukee, Wis.

The general tone or expression of physics teachers' meetings throughout the country for the past few years has been such as would give to an outsider the impression that the teaching of physics in high school is a failure. Although not at all in sympathy with this wholesale criticism yet I am not so optimistic that there is no room for improvement.

The experiment of segregation has undoubtedly many arguments in its favor, but whether or not it is doing the greatest good for the greatest number is the question. From my experience with girls and boys I cannot feel that it is the best solution. About one third of my classes are girls. Last semester the average of the girl's standing was five points above that of the boys and it was not entirely the result of better effort and memory. The best fifty per cent of the girls are equal in every way to the best fifty per cent of the boys. Many girls are good in mathematics, they are interested in the quantitative and technical por-

tions of physics. Many boys are not. To deprive such girls of that phase of physics is an injustice.

The most marked and distinctive basis of classification of our physics pupils is not according to sex but according to mental aptitudes. The best high school pupils can be divided largely into two classes: those whose method of study involves logic, reason, understanding; and those who depend principally upon a retentive memory. The present method of adapting the subject-matter of physics to the so-called average student is an injustice to both of these classes.

To that class of students who are not scientifically or mathematically inclined, the returns from the technical and quantitative portions of the subject are not commensurate with the time and effort. They are nevertheless just as interested in and capable of comprehending the general information of the subject, but the lack of perfect understanding tends toward discouragement and dissatisfaction. With the other class the injustice is even greater. They are held back, their time to some degree wasted. The inability and constant drill of the others tends to encourage laziness rather than bring out their best efforts and possibilities.

If such an analysis of the situation is correct the solution of the difficulties can be obtained by dividing the subject-matter and presenting as two different courses which I shall call, for lack of better terms, elementary and advance. An experiment which I have wished to try for several years but was not able before to obtain permission. The first semester of next year we will offer the elementary course which will present in a qualitative way the more essential and practical principles of physics with special emphasis on applications. The laboratory exercises will be of the nature of diagrams and explanations of home, school, and city appliances rather than the verification of laws and principles. The second semester will be the advance course which will cover the more difficult, quantitative, and technical portions of the subject. Class room discussion to correlate with the laboratory work, which will cover about forty of the usual type largely quantitative experiments.

Credit toward graduation will be given for the elementary course whether or not the advance course is taken. (Students expecting to receive credit for physics in college or university will need to elect both courses.) Such a division of the subject-matter with the privilege of electing one or both courses will largely eliminate the injustices mentioned above. The elementary

course will be interesting, comprehensive, and instructive to all, while the advance course with the backward students eliminated, will be presented in a more strenuous and intensive manner with far greater results to pupils. Students are better able to comprehend the difficult parts after a survey of the elements of the subject. Some students will have had a semester more of mathematics thus better prepared for the quantitative parts of physics.

The nature of the laboratory work in connection with the elementary course is a decided change from the ordinary. The following is a list, with a word or two in explanation, of the experiments or exercises which are to be performed at home or outside of the regular class period:

BAROMETER.—Barometric curve. Relation of curve to the weather changes.

RELATIVE HUMIDITY.—Determined in school. In home, living room and kitchen. In open air.

SCHOOL VENTILATION.—Determine volume of fresh air per pupil per hour. Also space per pupil. Compare with state requirements.

HOME VENTILATION.—Determine volume of fresh air per person per hour in living room. (A gas or oil light equal to two persons.)

PUMPS.—Cross-section diagram with explanation of valve action.

HYDRAULIC RAM.—Diagram of model with explanation of action.

HOME PLUMBING SYSTEM.—Diagram showing connection of all hot and cold water pipes in home.

GAS METER.—Diagram and reading each week for month. Cost of gas per week per person.

COOK STOVE.—Cross-section diagram. Purpose and manipulation of dampers.

HOME HEATING SYSTEM.—Diagram and explanation. Control and action of dampers. Proper manipulation of furnace.

HOT WATER TANK.—Diagram and explanation.

SCHOOL HEATING SYSTEM.—Diagrams and explanation of furnace, boiler, and radiators for one room for each floor.

SCHOOL VENTILATING SYSTEM.—Diagram with full explanation.

EFFICIENCY OF GAS STOVE.—Compare B. T. units obtained in kettle to the units in gas consumed. Compare kettles of different material. Compare different burners.

CITY WATER SYSTEM.—Suitable diagrams with explanation.

SCHOOL THERMOSTAT.—Diagrams and explanation for control of one room.

DOOR BELLS.—Diagram of wiring, front and rear door connections. Explanation of bell.

TELEGRAPH.—Diagram and explanation of system in laboratory.

EFFICIENCY OF ELECTRIC HEATER.—Compare B. T. units obtained in vessel with the units consumed. (1055 watts = 1 B. T. U. per second.) Compare in efficiency and economy with gas burner.

COST OF HOME LIGHTS.—From candle power and meter determine cost per candle power per hour. Repeat with gas light. Compare.

Several of the above exercises have been assigned and performed by the students during the present year. The unusual interest aroused not only in students but in parents as well in such investigations has been exceedingly gratifying. The ignorance displayed by some of the best students of the working principles of some of the most common home appliances is convincing that it is a much-needed phase of physics instruction. With such a course the assignments can be varied to suit the need and ability of the individual student; an adaptation highly desired but almost impossible in the large schools under present methods. One of the most serious defects in our present laboratory treatment of physics is our inability to have the laboratory exercise correlate with the class room discussion. Unless there is that perfect correlation the laboratory day is bound to be a break or diversion in the class room treatment of the subject-matter. The experiments or problems as planned above will cause no interruption in the elementary course. While in the advance, which is more of the nature of a laboratory course, the class room discussion will be adjusted to the experiments of the laboratory. Here the experiment will precede the recitation; an ideal order, which is impractical in many instances under present methods. With the general information gained in the elementary course the student is now able to proceed with more independence in his laboratory work.

One of the criticisms of such a division of the subject will be that the treatment will need to be too superficial if the entire subject is to be covered in one semester. By eliminating some

of the quantitative parts which receive an undue portion of time and drill and remembering that the laboratory work takes about one third of the time devoted to the subject we will find that there is ample time in one semester for the subject-matter remaining to receive just as intensive consideration as at present. Furthermore, high school physics is not a complete treatise of the subject and no two persons are agreed as to just what should be eliminated. If we were to take only that subject-matter which we find common to the recent high school text-books, one semester uninterrupted by laboratory days, would be sufficient time for its consideration.

About seventy-five per cent of all of our students graduating have had physics. This we believe is a good showing for a subject that is required in only one course. By the method of division we believe that this percentage will be increased. Many students who do not now elect physics because of its reputation of being mathematical and difficult will be attracted to this one semester popular treatment of the subject. Once interested more will elect the second course. No other science or subject of the high school offers subject-matter so closely related to everyday life and affairs, consequently the essentials, at least, of the subject should be presented in such a manner that the course could be unhesitatingly recommended and urged, if not required, of every boy and girl before graduating from high school.

PORTLAND CEMENT IN THE PHILIPPINES.

At the present time there is no Portland cement manufactured in the Philippines. Consequently concrete work is expensive. It is understood, however, that if the raw materials, fuel, etc., can be secured in locations favorable for transportation, that two or three mills will soon be erected.

BY-PRODUCTS OF COAL.

From one ton of ordinary gas coal may be produced 1,500 lbs. of coke, 20 gallons of ammonia water and 140 lbs. of coal tar. By distillation the coal tar will yield 69.6 lbs. of pitch, 17 lbs. of creosote, 14 lbs. of heavy oils, 9.5 lbs. of naphtha yellow, 6.3 lbs. of naphthaline, 4.75 lbs. napthol, 2.25 lbs. alazarin, 2.4 lbs. solvent naphtha, 1.5 lbs. phenol, 1.2 lbs. aurine, 1.1 lbs. benzine, 1.1 lbs. aniline, 0.77 lb. toludine, 0.46 lb. of anthracite and 0.9 lb. of toluene. From the latter is obtained the substance known as saccharine, which is 230 times as sweet as the best cane sugar.

THE TEACHING OF MATHEMATICS IN THE MIDDLE SCHOOLS OF SWITZERLAND.

By M. O. Tripp, Ph.D.,
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The position of Switzerland in educational affairs is more important than her territory, population, and natural resources would lead one to expect. This land of Rousseau and Pestalozzi is actually in the forefront of European nations in public education. The public elementary schools are free like our own; and, like the United States, the general government exercises very little direct control, the schools being under the immediate management of the various cantons, just as our schools are managed by the different states. The only example of direct federal control is the famous technical school (*Eidgenössische Polytechnikum*) in Zürich. This lack of direct central authority gives the cantons an opportunity to arrange their courses of study so as to meet the wishes of the people in each region. It cannot be said that there is any one prevailing system of national education. The great variety in language and religion tends to produce different educational ideals.

The *middle schools* of Switzerland are those between the primary schools having a six years' course and the university. In German Switzerland these schools are usually called *Kantonschulen* or *obere Realschulen,* while in French Switzerland they receive the name of *collège* or *gymnase;* the latter class of schools is divided into a *division inférieure* of about three years and a *division supérieure* of about four years. Frequently different courses are given in the same school, such as classical, scientific, or technical; and sometimes there are separate classes according to the language of instruction, the subject-matter being the same in each class. In the *Collège de Genève* there is a course called *section réale,* the work corresponding closely to that of the German *Realgymnasium,* in which emphasis is placed upon the study of modern languages and Latin. In French Switzerland the *middle schools* are much like the French Lycées, and the methods of instruction are similar to those of the French institutions. Naturally in Eastern Switzerland the influence of German pedagogy is strong.

As regards the scope of mathematical instruction in the *middle schools* there is great diversity in the various cantons. The most common practice is to give courses in arithmetic and observa-

tional geometry during the first two years, the students in these courses averaging from twelve to fourteen years of age. In general, arithmetic occupies more than twice as much time as geometry, both together being taught about five hours per week. The instruction in algebra usually commences in the second or third year and is given from one to two hours per week; about half the schools begin the work in the second year and about half in the third year. The work in demonstrative geometry is not usually begun until the student has had a propædeutic course of from one to three years in intuitive geometry. The most advanced courses extend considerably beyond our high school work. Most of the mathematical subjects taught in our freshman and sophomore classes are given in the Swiss *middle schools*. Classical courses are usually concluded by a course in plane analytic geometry, while the scientific courses generally include solid analytic geometry, descriptive geometry, and calculus. About eighty per cent of the *Realschulen* give courses in calculus, while about eighty per cent of the other *middle schools* do not give courses in that subject. Calculus is treated in a more elementary way than in our colleges. Brandenburger in his book, *Der Mathematische Unterricht in der Schweiz*, gives an interesting discussion of the aims in the study of calculus as reported by the various instructors in the Swiss *middle schools*, the general agreement being that instruction should be confined to the ideas of differential quotient and the integral of a function, together with the simplest applications to geometry and physics.

Our elementary and high school period of twelve years corresponds very nearly to the time spent by the Swiss in the *primary* and *middle schools*, and yet we cover much less ground. Not only in the scientific and technical courses, but also in the classical, the Swiss lay great stress on mathematics. Professor Fehr of Geneva, Editor of *L'Enseignement Mathématique*, speaking before the International Congress of Mathematicians at Rome, in 1908, said: "Personne ne conteste chez nous que les mathématiques appartiennent à l'ensemble des connaissances qui forment la culture générale indispensable à toutes les carrières liberales et chacun reconnait que les elements que l'on enseigne dans les gymnases sont à la portée de tout cerveau normalement constitué."

Besides the subjects usually required for admission to an American college, the Swiss universities generally insist upon trigonometry and conic sections as prerequisites to all mathematical

courses in the university. It is true that the universities usually give work in plane analytic geometry, but it is of a more general nature than that offered during the freshman and sophomore years in American colleges.

The Swiss trade schools, of which there are three hundred, exert a powerful influence upon the mathematical instruction. The introduction of horology into the schools during the eighteenth century acted as an incentive to the study of mathematics. Thus the circle and the calculations concerning it; the measure of angles and the considerations concerning cog-wheels, contributed to the elevation of geometry and trigonometry. In order to carry out the exact constructions necessary in making watches and instruments of precision the Swiss turned to the exact sciences. The great variety of trade schools shows that there is every effort to make the schools prepare for the real lifework of the average citizen.

One marked contrast between the teaching of mathematics in this country and in Switzerland consists in the use made of the text-book. Many Swiss schools use text and exercise books, while others use neither; some schools use exercise books but no text-books. The use of text-books without exercise books is very exceptional. In America there is a strong preference for the use of text-books, while in Switzerland, as in general in continental Europe, there is a great aversion for text-book instruction. Although the Swiss teacher generally recognizes that much time is lost in dictating theory and exercises, yet there is the feeling that what the student sees developed before his eyes he comprehends more fully than when he studies from a text. Teaching without a text-book has the advantage of inciting the teacher to greater activity and responsibility, but this does not always mean greater activity of the students. If outside study and preparations of lessons receive little emphasis, as in the German *Gymnasium,* then it would seem that the method of developing the theory in the class room is especially advantageous; but any course of study in which students do not learn to use books, and thus to work independently of the teacher, is particularly defective.

In the *Collège de Genève,* one school where I made observations, the lecture method was followed. The instructor spoke slowly following notes, and the pupils took down every word that was said. The method was much the same as that of the university. This long and tedious reproduction of the ordinary text-book theory did not impress me as being the best use of the

time allotted to the subject. One or two periods per week were given to the consideration of exercises, just as is usually done in the more elementary courses in the universities. This tendency to lecture may be observed in French schools, but it is not the plan usually followed in the German schools.

The limited use of the blackboard in mathematical instruction in European schools is a surprise to the American observer. One small blackboard near the teacher's desk, and that largely for the individual use of the teacher, seems to be the common rule. Teachers in this country generally feel that a large amount of blackboard work is an absolute necessity. An observation of the methods employed in teaching mathematics with a small amount of blackboard work tends to make one feel that we overemphasize the importance of the blackboard. American teachers often feel that students are doing good work if demonstrations and solutions are written out accurately and in correct form; and hence they frequently do not spend much time in discussing the real spirit of the mathematical processes involved. In this way the purely mechanical side is brought into great prominence to the neglect of sound reasoning. The ability to explain from a figure without previously writing a demonstration is very desirable; and it is something too often neglected in our schools. It is more difficult, I believe, in American than in European schools, to get students to "chalk and talk" simultaneously.

As a prerequisite for a license to teach in the Swiss *middle schools* most of the cantons require a full university course of from four to five years, a standard which is considerably higher than that obtaining in American high schools. In the Canton Waadt the candidate must possess a *Licence ès-lettres,* for which rank two to three years' university study is required. It is, therefore, about the same as our bachelor's degree. Several cantons give preference, for mathematical positions, to those teachers who have taken a diploma in engineering, maintaining that in this way the applications of mathematics will receive more attention. Considerable stress is laid upon the pedagogical preparation of candidates for positions in the *middle schools,* but there is seldom any official regulation in regard to such preparation.

In the University of Geneva Professor Fehr gives pedagogical courses in the teaching of elementary mathematics which are well attended. In conversation with the writer this noted professor said that teachers of mathematics usually spend two years in general university studies and then one year of specialization

in mathematics above the regular course in calculus. He said that in the future it was quite probable that there would be a doctorate requirement. As an evidence of progressiveness I quote the following resolution passed in 1904 by the *Swiss Association of Mathematical Teachers*: "It is desirable that in higher secondary instruction, notably in the gymnasiums, a greater place shall be given to the historical development of mathematics." The organization of vacation courses for mathematical teachers in the *middle schools* also shows the great interest of the Swiss in the teaching of mathematics.

The hope of democracy lies in the education of the whole people; and hence it is that such a pure democracy as Switzerland takes educational affairs very seriously, much more so than we do here in America, for it is generally conceded that their government, as an expression of popular control, is superior to our own. Naturally it is in the field of mathematics that seriousness in education is most keenly discernible, for in this domain it may be said with certainty that nothing comes without labor.

HISTORY OF THE GRAPH IN ELEMENTARY ALGEBRA IN THE UNITED STATES.

By Emily G. Palmer,
Salem, Oregon.

The "Committee of Ten" in their report in 1893 mentioned vaguely the correlation of the several branches of mathematics but suggested no plans. Until about twelve years ago very little had been done toward the correlation either of the different branches of secondary mathematics or of any of these branches with the practical world. Some demand has arisen for more concrete problems and here and there a few teachers were using the graph, but no text-book in elementary algebra printed before 1902, which I have been able to find, introduces any of the theory graphically.

To Professor Perry of England we are largely indebted for the impetus given this phase of our instruction in mathematics. The introduction of the graph into elementary algebra was one of his first steps toward the correlation of algebra with industrial work and he urged its use in his address before the British Association for the Improvement of the Teaching of Mathematics in Glasgow in 1900. The next year the Mathematical Association of London gave as their opinion "that graphs should be intro-

duced as early as possible and be used extensively, certainly in connection with simultaneous linear and quadratic equations."

As a result of this agitation and interest in graphic algebra the need of suitable text-books was felt and small pamphlets for supplementary work in the graph appeared, such as the monograph published by D. C. Heath & Co. in 1902 as a supplement to the Wells Algebra. The very first number of School Science and Mathematics gives a list of such books and pamphlets to supplement the algebras of that day.

Still authors of text-books were conservative and inserted the work on graphs after the whole discussion and solution of simultaneous equations. The text was so arranged that the teacher might omit the chapter on graphs without in any way destroying the continuity of the work.

In 1903 the American Mathematical Society appointed a special committee to prepare standard formulations of college entrance requirements in mathematics, in coöperation with committees already appointed by the Society for the Promotion of Engineering Education and by the National Education Association. Their report, after listing the topics to be included in elementary algebra, says: "The use of graphic methods and illustrations, particularly with the solution of equations, is also expected." This report is signed by Professor H. W. Tyler of Massachusetts Institute of Technology, Professor T. S. Fisk of Columbia University, Professor W. F. Osgood of Harvard, Professor Alex Ziwet, University of Michigan, and Professor J. W. A. Young of Chicago University.

In response to this positive stand taken by leaders in the mathematical world and to the growing feeling among the rank and file of teachers of algebra that the graph is a useful tool, most of our algebras published since 1905 have introduced the negative number and simultaneous equations by means of the graph.

As the use of graphical methods in equations showed the strong appeal that concrete work makes to the minds of the pupils, other uses have been found for the graph in the representation of positive and negative numbers, squaring of a binomial, the direct solution of problems, tables of values and statistics of all kinds. Although there are some algebras published even within the last year which do not make any use of graphical methods and some teachers who are doing little or nothing with it, still its use seems widespread enough to prophesy that it has made a place for itself in elementary mathematics.

THE CATALPA SEPTUM.[1]

A Factor in Distinguishing Hardy Catalpa.

By William H. Lamb.

The purpose of this discussion is to select a single character, by means of which those who are unfamiliar with the technique of botany may be able to distinguish hardy catalpa (Catalpa speciosa) from the common catalpa (Catalpa catalpa).

Many plant species are not distinguished by one character alone, but by the combination of numerous small but constant differences. Unfortunately this is true of our two species of catalpa. Very unlike in silvical qualities, these two forms are extremely similar in botanical characteristics. In fact, the leaves, flowers, seeds, and even the pods, are so nearly alike that the identity of a specimen may often prove puzzling, even to one who has an excellent knowledge of our forest trees.

It is practically impossible to distinguish between the two species of catalpa from the leaves alone. It is true that the leaves of common catalpa are stronger scented and not quite so long pointed as those of hardy catalpa, but these distinctions are very slight, and, being entirely relative, are practically of no value.

The flowers furnish a better means of identification. Those of common catalpa are thickly spotted on their inner surface, and the lower lobe of the corolla (the white part of the flower) is not notched, while those of hardy catalpa are not so thickly spotted and the lobe of the corolla is slightly notched. But catalpa flowers are fragile and only available for a short time in the spring, and even then such distinctions are of little value except as a means of comparison.

Identification from the seeds alone is most difficult. These two species have seeds so very much alike that although the two forms may often be separated when placed side by side, yet with a single specimen at hand specific identification is most precarious.

The pods are essential for positive identification; but even with these it is difficult to distinguish the species because of their extreme variability in size. In general the pods of hardy catalpa are larger than those of common catalpa. However, pods of common catalpa are found practically as large as the largest of the hardy catalpa. According to Dr. Sargent,[2] the pods of hardy

[1]Proceedings of the Society of American Foresters.
[2]Sargent's Silva VI, 87, 90.

catalpa are 8 to 20 inches long and those of common catalpa 6 to 20 inches in length. So the size of the pod is absolutely of no value as a distinguishing feature.

There is, however, one character which seems to be entirely dependable—the septum.

The septum is the long, wrinkled partition in the pod, along which the seeds are arranged. This septum, or pod-partition, may be flat or rounded in general outline, and this variation in shape furnishes a valuable means of distinguishing hardy catalpa.

The septum of hardy catalpa, an enlarged section of which is shown diagrammatically by figure 1, is rounded in general outline. The septum of common catalpa (figure 2) is only thickened along the middle. On account of the fact that the septum is very ir-

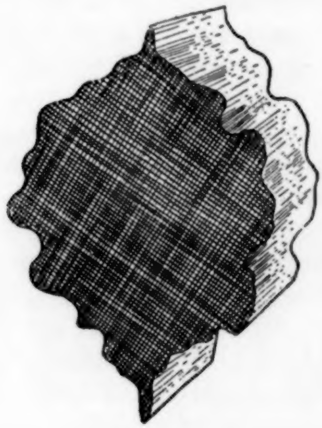


FIG. 1.

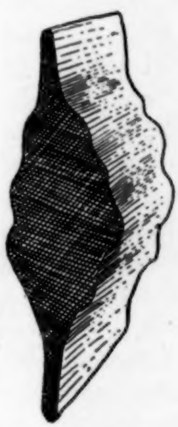


FIG. 2.

regular and not of uniform thickness throughout, places may be found in the septum of hardy catalpa that are considerably flattened, approaching the shape shown by figure 2, but no pod of common catalpa has ever been observed by the writer with a septum as thick in any place as shown by figure 1.

This important distinction has never been sufficiently emphasized, and will, it is believed, prove to be the most dependable single factor in the identification of hardy catalpa.

REINDEER PROGRESS IN ALASKA.

By Lillian E. Zeh.

The herding and breeding of domesticated reindeer, introuced as an experiment a number of years ago, with animals imported from Siberia by the Government, has now become the most prominent feature of the industrial education of the Eskimo, and the main activity of many native villages of Arctic Alaska. The progress in civilization that has been made by lifting up the natives, formerly living as savages and eking out a precarious existence by hunting, with no other domestic animal than the dog, to the estate of civilized, self-supporting herdsmen, as accomplished through the reindeer industry, is a remarkable educational achievement.

The Alaska Reindeer Service has now reached its most successful stage, as it marks the beginning of the period of full utilization of all the reindeer owned by the Government for the benefit of the native population. At the present time there is hardly a surplus government reindeer north of the Kuskokwim River. This has been made possible by the establishment of new reindeer stations, by the employment of more natives as chief herders, by accepting the largest practical number of apprentices, and by transferring reindeer to both chief herders and apprentices in lieu of salary supplies, the chief aim and fundamental policy of the government being to turn the reindeer over to the natives as rapidly as the latter learn the industry and appreciate its value. The total number of reindeer in Alaska at the last census was nearly 23,000, and of this number over 11,000 are owned by the natives. One of the most striking and gratifying features is the large income which the natives derive from the sale of reindeer products, their share for the past fiscal year having been $18,-000 and over. This amount does not include the value of the reindeer skins used for clothing nor that of the meat consumed as food. These material benefits and the very considerable income thus derived demonstrate the fact that the reindeer industry has become one of the most prominent factors in the economic life of the Eskimo.

The total number of Alaskan reindeer is distributed in herds among twenty-eight stations, eighteen of these being owned by the government and ten by church missions. The Lapps own over three thousand. The natives are very anxious to

get deer, and look upon them as a safe investment for their earnings, usually taking deer for services in preference to cash when an opportunity is offered. The government does not sell deer; this is done by natives and missions alone. The various missions are each furnished, by the government, a herd of one hundred deer on loan for a period of five years. At the end of this time the original number must be returned. The mission keeps the increase in fawns, which amounts to several hundred, derived from the government loan. The Moravian Mission of Bethel has one of the largest herds, nearly three thousand. Other missions having over one thousand deer, all in Arctic Alaska north of the Yukon, are located at Golovin, Kotzebue, Shishmerof, and Cape Wales. At Barrow, the most northern point on the American Continent, there is a herd of three hundred. The total population here is about four hundred men, women, and children. One native, "Takpuk," is considered the richest man of that region, as he owns a herd of one hundred and thirty-seven reindeer.

The missions support and educate a number of young apprentice herders. The native herders also take on apprentices and award them six deer a year in payment for their services. The Laplanders take a loan of deer for five years from the government and give their services as instructors for that period. At the end of five years the Lapp returns the one hundred deer and becomes an independent herder himself with the large increase of reindeer he has obtained from the herd. The Lapp herders are not interested in the extension of the reindeer among the natives. Some of the largest owners of deer are Lapps, at least a half dozen of these men have accumulated herds from five to eight hundred.

In introducing the reindeer as a means to promote the Eskimos' industrial life and to provide a permanent livelihood for them, it has been found necessary by the government to put the young natives through a course of training. Those who get their deer directly from the government serve an apprenticeship of five years. There are several hundred of these at present. They are bound by a written contract the strict terms of which they cannot violate without danger of losing their annual allotment of reindeer and suffering discharge from the service. This caring for, training, and breeding the deer is an education in itself, and the best which the government could give to the young natives. With careful training

the Eskimo boys make excellent herders. They readily learn how to take care of reindeer, to throw the lasso, to harness and drive the deer, and to watch the fawns. Siberian herders were at first imported to teach them, but of late years the more intelligent and efficient Laplanders, who have learned by centuries of experience the breeding of reindeer, have been secured. The Eskimo boys excel the Lapps in some respects; they can lasso better, and many become experts in making harnesses and sleds. The minding of the herd requires constant vigilance, especially in the spring during the fawning season. Then the herders have to keep watch with their rifles by turns, day and night, in order to protect the herd from the ravages of the Arctic wolf and the dogs. In the ear of each government deer a little aluminum button is fastened securely, and all private owners and herders have a mark which must be registered with a local superintendent of a reindeer station and also at Washington. Besides being taught the art of "deermanship" the apprentices are instructed in keeping accounts, in the methods of marketing reindeer, and in other practical matters connected with the industry. No apprentice can become a herder unless he is proficient in elementary reading, arithmetic, and writing. At the end of his apprenticeship the young Eskimo native is allotted a number of deer by the government, and with the increase obtained during the interval of his five years' service, each apprentice will have, on an average, a herd of fifty reindeer. As this herd will double itself every three years, the graduate apprentice will have a herd which will assure him a self-supporting income quite large enough to satisfy the economic wants of himself and family in the future. He is thus established in business by the government and is given free pasturage thereafter. A reindeer produces one fawn in the spring each year for ten years.

Among the useful and profitable products of the reindeer are the skins for clothing. Of these pelts most varied use is made. From them are fashioned the tight-fitting trousers and that wonderful outer garment, the "parka," universally worn in winter by both male and female natives and by many whites. The "parka" extends to the knees and has a close-fitting hood which keeps the head and shoulders comfortably warm even in the severest weather. These reindeer garments are remarkable for their excellent quality of resisting mois-

ture and cold. A close examination of the hair of reindeer furnishes an explanation of its peculiar value. The hair is not merely a hollow tubular structure with a cavity extending throughout its entire length, but is divided, or partitioned off, into exceedingly numerous cells like watertight compartments. These are filled with air, and their walls are so elastic and at the same time have such strong resisting power that they are not broken up, either during the process of manufacture or by swelling when wet. The cells expand in water, and thus it happens that a person clad completely in garments made of reindeer hair does not sink when in water, because he is buoyed up by the air contained in the hundreds of thousands of air cells.

As the mineral industry continues to grow in Alaska, the natives and graduate apprentices can earn high wages at teamsters, hauling supplies and furnishing fresh reindeer meat to mining camps in the interior at points remote from railway and steamboat transportation. Well-trained sled deer have been used to carry the mail 650 miles, from Barrow south to Kotzebue. This is the most northern mail route in the United States and likewise the most perilous and desolate mail trip in the world. Two trips are made a year and $750 is paid for each journey. The average speed is from 40 to 50 miles per day, the reindeer keeping up a steady trot. One of the latest and most remarkable feats, showing the capacity of the reindeer for sledge driving, was that accomplished by Mr. W. T. Loop, the superintendent of the government reindeer service. During the recent winter tour of inspection Mr. Loop traveled more than 2,500 miles with a reindeer sled over frozen tundra and ice-bound rivers of the lower Behring Sea region from the middle Yukon to the coast of the North Pacific. Part of this route for several hundred miles lay through a country which had been so little traversed that not even native trails had been made. The Alaskan reindeer service is under the direction of the United States Bureau of Education.—*Journal of Geography.*

THE JORDAN VALLEY.

By Frederick Homburg,
Woodward High School, Cincinnati, Ohio.

The rift that yawns between the highland of Judea, Samaria and Galilee on the West, and the land of Moab, of Ammon and of Gilead on the East is drained by the stream celebrated in song and story—the Jordan. It is formed in the north of the Holy Land by the confluence of three small streams which come leaping from the heights of Hermon. After union, the waters flow south through a swampy region including Lake Huleh, an unhealthy land, whose seedy thickets shelter gypsies and wild buffalo. On leaving this region the course of the stream becomes interesting. The level of the swamp is 2 meters above that of the sea; that of the Sea of Galilee, 16 kilometers beyond, is 208 meters below the sea level; so decided a difference in level for so short a distance means rapid flow, and we find the Jordan connecting the two basins by a series of cataracts through a deep, narrow gorge with steep basalt walls. The Sea of Galilee, or Lake Gennesaret, or Lake Tiberias, is a smiling sheet of fine, clear water, full of fish, once enlivened by fishermen's boats, now almost deserted. South of Lake Tiberias, between abruptly rising heights, there stretched a plain of varying width in which the Jordan has cut a sinuous and shifting channel. It meanders so, that its course from the Sea of Galilee to the Dead Sea is three times as long as the air line. The many rapids which justify the river's name, Jordan, meaning "swiftly flowing," render it unfit for navigation; and the low position of its sunken channel prevents its use for irrigating purposes. In spite of four bridges (the newest one near Jericho) the river is a hindrance to traffic, for its numerous fords are passable only at low water. Were it not for tradition and sentiment and the consequent attraction of tourists, and the fact that the Jordan affords drink to men and animals, it might be called a worse than useless stream.

The country about the river, whose water is often bottled and sent to Christian lands, there to be used at pompous baptisms, is private domain of the Turkish sultan. Toward the end of its course, the Jordan flows through a country which, outside of some oases, is nearly a desert and which foretells the nearness of the Dead Sea. The sacred waters of the Jordan do not mingle with those of other rivers in

the common ocean, but are lost in a lake without an outlet and without life. The shores, too, are of desolate aspect; hence its name is entirely appropriate—the Dead Sea. The absence of life is accounted for by the fact that the water is six times as salty as ocean water; and this is due to the minerals washed in from an arid land, and to enormous evaporation. The shores likewise are salty, hence perfectly bare and barren; salt pillars on the west side recall the story of Lot's wife. As in ocean water, the main solid in solution is common salt; but there is also magnesium chloride which adds bitterness, and calcium chloride which imparts a somewhat oily character. You need not be a swimmer to remain at the surface of the Dead Sea; for floating is no art in a liquid whose specific gravity is higher than that of the body. On emerging from the bath, the concentration of the brine and the dryness of the air cause the hair to become quite salty. When the water is agitated, the heaviness of the salty waves causes them to strike like iron, and they prove destructive to light boats. But the Dead Sea was not always so; ancient shore lines indicate that the Jordan Valley was at one time a fresh water lake with an outlet into the Mediterranean, and a surface some 30 meters above the level of the sea. In those days the Dead Sea and the Sea of Galilee were one; after the drainage ceased, and especially after the lakes were parted, salt accumulated in the lower one. The difference in level between the two lakes is quite marked; the surface of the upper lake being 208 meters, that of the lower 393.8 meters below the level of the sea; so throughout its course the connecting river has a very appreciable fall. But with all its swiftness, the Jordan could not have carved out this deep valley. Not connected with the sea and flowing far below sea level, where could it have deposited the material? The rocks of the valley sides and their dip prove that it is one of that rare type called rift valleys or valleys of fracture. The faulting may have been produced by a series of catastrophes; and they must have been veritably earth-shaking. History records a number of disastrous earthquakes in the Holy Land, proving that even recently this has been unstable ground, and the story of the destruction of Sodom and Gomorrah may have had such a calamity as its basis. The surface of the Dead Sea is nearly 400 meters below the surface of the ocean, and in places is nearly 400 meters deep.—*Journal of Geography.*

FIFTH INTERNATIONAL CONGRESS OF MATHEMATICIANS.

By J. W. A. Young,
University of Chicago.

The Fifth International Congress of Mathematicians was held at Cambridge, England, August 21-27, 1912. Meeting in a University which for rare beauty and charm of picturesque mediæval buildings and exquisite gardens can find a rival only in its sister university of Oxford, living in the rooms occupied in times past by generation after generation of the world's greatest savants, dining in halls of storied interest from whose crowded walls look down the likenesses of great men of many an age whom the world still delights to honor, royally entertained with that cordial hospitality for which the Englishman is so justly famed, the mathematicians who gathered at Cambridge from the four corners of the world lived through a unique week of their lives, and carried away with them a souvenir, never to be forgotten, of a Congress brilliant alike in historic and lovely surroundings, in elaborate social functions and in number and value of the mathematical lectures, reports and papers presented. The 670 members present (567 regular members and 103 members of their families) were registered from twenty-seven countries as follows:

Great Britain	250	Roumania	5
United States	82	Belgium	4
Germany	70	Brazil	4
France	52	Canada	4
Italy	38	Norway	4
Russia	38	India	3
Spain	25	Japan	3
Austria	19	Portugal	3
Hungary	19	Egypt	2
Sweden	13	Bulgaria	1
Holland	9	Chili	1
Switzerland	9	Mexico	1
Denmark	5	Servia	1
Greece	5		

The sessions of the Congress were of three types, general sessions, lectures, and sectional meetings.

At the first general session addresses of welcome were made by Sir G. H. Darwin, president of the Cambridge Philosophical Society, who in the course of his address paid a touching tribute to the memory of H. Poincaré, and by Mr. R. F. Scott, vice chancellor of the University. At the next general session Sir George Darwin was chosen president of the congress, and Lord Rayleigh was made honorary president.

Sir G. Greenhill made the following statement in regard to the work of the international commission on the teaching of mathematics:

The statement I have to make, sir, to the congress is given in the formal words following:

1. The International Commission on the Teaching of Mathematics was appointed at the Rome Congress, on the recommendation of the members of Section IV.

2. The several countries, in one way or another, have recognized officially the work, and have contributed financial support.

3. About 150 reports have been published, and about 50 more will appear later.

4. The Commission will report in certain sessions of Section IV.

5. The Commission hopes to be continued in power, in order that the work now in progress may be brought to completion.

A resolution to this effect will be offered at the final meeting of the Congress.

The third general session closed the Congress. At this session, upon motion of C. Godfrey, seconded by W. von Dyck, the following resolution was unanimously passed. Its adoption had previously, upon the motion of Sir George Greenhill, been unanimously recommended to the congress by the International Commission on the Teaching of Mathematics, in its separate session, and by Section IV (b) in joint session.

"*Resolved,* That the Congress expresses its appreciation of the support given to its Commission on the Teaching of Mathematics by various governments, institutions, and individuals; that the Central Committee composed of F. Klein (Göttingen), Sir G. Greenhill (London), and H. Fehr (Geneva) be continued in power and that, at its request, David Eugene Smith of New York be added to its number; that the delegates be requested to continue their good offices in securing the coöperation of their respective governments, and in carrying on the work; and that the Commission be requested to make such further report at the Sixth International Congress, and to hold such conferences in the meantime, as the circumstances warrant.

It was decided that the next Congress be held at Stockholm in 1916.

Professor A. G. Webster appropriately voiced the heartfelt appreciation and thanks of the members of the Congress for the most cordial hospitality so lavishly showered upon them collec-

tively and individually by their gracious hosts, and all present expressed their hearty participation in what he had said by prolonged applause and an enthusiastic rising vote. Thereupon a few fitting words of the chairman, Sir George Darwin, brought to a close the Fifth International Congress of Mathematicians.

On the afternoon of the last day of the Congress a procession of members proceeded to Cayley's grave and there deposited a wreath in his memory. Funds were secured for the preparation of a silver wreath to be presented to the University as a permanent tribute of respect and honor from the Congress to this great Cambridge mathematician.

The general lectures were as follows:

F. Enriques: Il significato della critica dei principii nello sviluppo delle matematiche.

E. W. Brown: Periodicity in the solar system.

E. Landau: Gelöste und ungelöste Probleme aus der Theorie der Primzahlverteilung und der Riemannschen Zetafunktion.

Prince B. Galitzin: The principles of instrumental seismology.

Bôcher, M.: Boundary problems in one dimension.

Borel, E.: Définition et domaine d'existence des fonctions monogènes uniformes.

Larmor, Sir J.: The dynamics of radiation.

White, Sir W. H.: The place of mathematics in engineering practice.

The sectional work was carried on in the following sections:

I. Arithmetic, Algebra, Analysis.
II. Geometry.
IIIa. Mechanics, Physical Mathematics, Astronomy.
IIIb. Economics, Actuarial Science, Statistics.
IVa. Philosophy and History.
IVb. Didactics.

The International Commission on the Teaching of Mathematics held one session separately, and three sessions jointly with Section IVb.

Space will not permit an enumeration even of the titles of all of the papers presented in the various sections. It must suffice to say that 28 papers were listed in Section I, 22 papers in Section II, 18 papers in Section IIIa, and 11 papers in Section IIIb.

Section IVb held six meetings (two of them jointly with Section IVa), under the chairmanship of the following gentlemen in order: Hon. B. A. W. Russell, C. Godfrey, D. E. Smith, A.

Gutzmer, E. Czuber, C. Bourlet, J. W. A. Young, Sir J. J. Thomson, R. Fujisawa, C. Godfrey.

Three of these sessions were held jointly with the International Commission for the Teaching of Mathematics.

The first of these sessions was opened by an address of welcome by the chairman, C. Godfrey. Thereupon, an address on the work of the commission was delivered by David Eugene Smith, who had been in recent conference with the president of the commission, Professor Klein, and the Central Committee.

"As has already been mentioned, Professor Klein, to whose great energy and wisdom the success of the International Commission on the Teaching of Mathematics is largely due, is unable to be present, on account of illness. It was my privilege to propose to the delegates at our meeting on Wednesday the sending of a telegram to Professor Klein, and I now propose the same message to Section IV, as follows: 'The International Commission on the Teaching of Mathematics, and Section IV, at their first Cambridge meeting, express regret at your absence and best wishes for your recovery."[1]

The Commission was organized for the purpose of reporting upon the present status of the teaching of mathematics in the various countries of the world. Special subcommittees have also been appointed from time to time to consider questions of international rather than merely national interest. About one hundred and fifty reports on the work done in the various countries have been prepared, and at least fifty more are in contemplation. A world-wide interest in the improvement of mathematical teaching has been awakened, and the influence of the movement is certain to be very far-reaching. Ten countries have completed the task set for themselves. In chronological order of completion these countries are Sweden, Holland, France, Switzerland, Austria, Japan, the United States of America, the British Isles, Hungary, and Denmark. In process of publication is the monumental work of Germany, with twenty-seven out of thirty-six reports already printed, and the reports of Italy, Roumania, Spain, and Russia. In contemplation are the reports of Greece, Norway, Australia, Portugal, Servia, and doubtless of several other countries.

As to the future work of the Commission, the Central Committee earnestly desires that it be authorized to see to the com-

[1]By unanimous vote the telegram was duly sent.

pletion of the reports. It is therefore very desirable that it be continued in power, both for this purpose and for the consideration of certain questions of great international significance. Such topics as the proper training of engineers, of calculus in the secondary schools, of the general value of intuition in the teaching of mathematics, of the training of teachers, and of the educational (cultured, disciplinary, nontechnical) value of mathematics, may properly occupy the attention of the Commission in the next four years. Special conferences having already been held, at Brussels and Milan, it is proposed, if the Committee is continued in power, to hold others between now and the time of the meeting of the Congress of 1916, if that shall be the date. Possibly such conferences may be held in France in 1914, in Germany in 1915, in Stockholm in 1916.

It is also hoped that each country will prepare a summary of the large features of the reports of other countries, to the end that the work that has been accomplished may have its full effect. It is further hoped that the various countries will continue the financial support that has been given to the Central Committee in the past.

A word should be said at this time in memory of those distinguished teachers who have been connected with the movement, but who have been called from their labors to solve the great problem. Soon after the last Congress adjourned, Professor Vailati of Rome, a distinguished writer and an accomplished scholar, passed away. Scarcely in his full prime of life, his loss is felt not by Italy alone, but by all who appreciate scholarship and high educational standards. Professor Bovey, president of the Imperial Technical College at South Kensington, and who was charged with the labor of reporting for Canada, has also been called from us. In his death the world lost a scholar and an administrator of prominence. And as he was planning to attend this Congress, four weeks ago to-day, Geheimrath Professor P. Treutlein of Carlsruhe passed suddenly away. In his death Germany lost one of her foremost educators, and the International Commission one of its best supporters.

We shall now proceed to the election of the officers for the next session, and then to the reception of the reports. The Central Committee has consulted with the Committee on Organization and it has been decided that the first set of reports shall be presented to the Library of the University of Cambridge, a second set to our official hosts, the Cambridge Philosophical So-

ciety, and a third set to that great world library, the Library of the British Museum.

The General Secretary of the Commission next made a statement as to the work of the Central Committee, and submitted its collected publications.

Thereupon the reports of the various countries were formally submitted to the Congress. The countries were called in alphabetical order in the French language, and the following members of the commission presented the reports, with a brief oral description, and a longer written statement, which will be published in the Proceedings of the Congress, and in the official organ of the commission, *L'Enseignement Mathématique.* The statement accompanying the American report will be published in SCHOOL SCIENCE AND MATHEMATICS, the official American organ.

Germany Prof. A. Gutzmer (Halle)
Austria..Prof. E. Czuber (Vienna)
Belgium .Prin. E. Clevers (Ghent)
Denmark ....Prof. H. Fehr
Spain .....Prof. Toledo (Madrid)
United States ....
Prof. J. W. A. Young (Chicago)
France...Prof. C. Bourlet (Paris)
Greece ....Prof. H. Fehr
Holland. Prof. J. Cardinaal (Delft)
Hungary ....
......Prof. E. Beke (Budapest)
British Isles ....
Prof. C. S. Jackson (Woolwich)
Italy ....
...Prof. G. Castelnuovo (Rome)
Japan ..Prof. R. Fujisawa (Tokio)
Norway ....
...Prof. M. Alfsen (Christiania)
Portugal ....
...Prof. F. J. Teixeira (Oporto)
Roumania ....
..Prof. G. Tzitzeica (Bucharest)
Russia ....Prof. H. Fehr
Sweden ....Prof. H. Fehr
Switzerland ....
........Prof. H. Fehr (Geneva)

Also the following associated countries:

Brazil ..Prof. E. de B. R. Gabaglia
.............(Rio de Janeiro)
Servia ....
Prof. M. Petrovitch (Belgrade)

At the second joint session of Section IVb and the International Commission the report of subcommission B on "The mathematical education of the physicist in the university," was presented by Professor C. Runge, and followed by a lively discussion.

At the last joint session of Section IVb and the International Commission C. Goldziher presented a report on the work done by David Eugene Smith and himself toward preparing a bibliography of works on the teaching of mathematics, published since 1900. (This bibliography is about to be published by the United States Bureau of Education and can be obtained from

the bureau on request). Upon motion of Professor Smith the following resolution was passed:

"*Resolved,* That Section IVb of the International Congress of Mathematicians, assembled at Cambridge, expresses its thanks to the Honorable the United States Commissioner of Education for his great interest in publishing, for free distribution, the recent bibliography on the teaching of mathematics (1900-1912), and the hope that it may, through his good offices, be brought to completion to the year 1915, with such additions to the present list as may seem desirable."

David Eugene Smith then presented the report of Subcommission A on: Intuition and Experiment in Mathematical Teaching in Secondary Schools. The presentation of the report was followed by an extended discussion. This report will be published in the various official organs named above.

In the other sessions of Section IVb the following papers were presented:

Whitehead, A. N.: The principles of mathematics in relation to elementary teaching.

Suppandschitch, R.: Le raisonnement logique dans l'enseignement mathématique universitaire et secondaire.

Hill, M. J. M.: The teaching of the theory of proportion.

Hatzidakas, N.: Systematische Recreationsmathematik in den mittleren Schulen.

Gérardin, A.: Sur quelques nouvelles machines algébriques.

Carson, G. St. L.: The place of deduction in elementary mechanics.

Nunn, T. P.: The proper scope and method of instruction in the calculus in schools.

It was not possible to secure brief abstracts of the above papers for incorporation in this report. The papers will be published in full in the Proceedings of the Congress, and elsewhere.

This account of the Congress would be lamentably incomplete without brief mention of its social side. First of all, the four official receptions, that by Sir G. H. Darwin, president of the Cambridge Philosophical Society, in St. John's College, on Wednesday evening; that by Lord Rayleigh, chancellor of the University, in the Fitzwilliam Museum on Friday evening; that by the president of the Congress in Christ's College on Sunday afternoon; and finally that by the master and fellows of Trinity College on Monday evening. These brilliant functions, each in a unique setting with a charm all its own, will remain in memory

as pictures not to be forgotten. Sunday was fittingly closed with an organ recital in King's College Chapel, the most lustrous of all of Cambridge's architectural gems. Visits to the Observatory and to the Cambridge Scientific works, with attendant teas, excursions to Ely, to Oxford, and to Hatfield House, were temptations that caused the devotion to his science of more than one mathematician temporarily to waver. Besides all this an able and enterprising committee of ladies had prepared for the ladies of the Congress a most attractive series of visits to the colleges, of drives and teas in Cambridge and its environs, and of excursions to various points of interest that seemed to leave no moment without something tempting to do. Whether viewed from the social side or from the mathematical side, the Congress must be pronounced a complete success.

THE REPORT OF THE UNITED STATES OF NORTH AMERICA.

I. Address of Presentation.

The American report has already been published in full and widely circulated, so that only a few words are needed in making its formal presentation to the Congress.

The report consists of a general report giving a bird's-eye view of the entire field and twelve special reports, each subdivided further, giving detailed views of particular fields and together covering the entire ground of mathematical instruction in the United States. In the preparation of these reports nearly three hundred of the leading mathematicians and teachers of the country have collaborated.

The excellent preliminary report of the Central Committee was in the hands of all as sounding the keynote and giving the general program of the work. Accordingly, the reports are essentially descriptive in character, giving an account both of actual conditions and present-day tendencies, but making no attempt to provide solutions for the problems, large and small, with which the United States has to deal. Naturally, however, many such problems have been mentioned in the reports. These latter must therefore surely prove stimulating and helpful to our country by explicitly bringing the conditions and needs of the entire mathematical field to the simultaneous attention of the whole country in a single, systematic presentation.

Time will not permit me to speak to-day of more than one of the problems in the teaching of mathematics which the United

States now confronts. In this international gathering perhaps the most interesting one to mention is one springing out of the exceptional measure of freedom which American educational institutions enjoy. There are in the United States thousands of independent centers of educational authority, each legally as free to treat its work without regard to any other or to any common superior as are England, Russia, and Japan. This absence of central authority and legislation with its attendant constraint is accompanied by a corresponding absence of central and authoritative study of problems with its attendant stimulus and helpfulness. How to secure for the work in mathematics some of those benefits which can be attained only by concerted study and action without sacrificing an undue measure of that local liberty which the spirit of the country demands is one of the most serious problems now confronting the United States.

Mr. Chairman, I have the honor now formally to present to the Congress the Report of the United States of North America.

II. Written Sketch of American Conditions.

In the United States of North America there are 48 states, each of which is self-governing, except in those items specially entrusted to the central government by the constitution. Among these items the formation and administration of an educational system is not found. Consequently there exists no national authority in educational matters in the United States, the largest unit of authority being the state. That there are not forty-eight or more widely different educational systems in the country, that a large measure of uniformity does exist in the educational work of the whole country, that it is possible to speak of a single educational system found (with local variations) throughout the whole country, is due simply to the homogeneity of thought and life of the country and not to any constitutional requirement.

Normally the pupil passes in order through the following types of schools: *Kindergarten,* 3 years (age at entrance 3 years); *elementary school,* 8 years (age at entrance 6 years); *secondary school,* 4 years (age at entrance 14 years); college or institution of collegiate rank, four years, (age at entrance 18 years); university or institution of university rank, 3 or more years (age at entrance 22 years). Generally speaking, the completion of the work of an elementary school is required for admission to a secondary school; similarly, completion of the work of a secondary school is prerequisite for admission to an institution

of collegiate rank, and finally the diploma of a collegiate institution is the basis of formal admission to university work. There is practically but one type of the elementary school, which is the common basis for all subsequent work. In the other institutions there are various types and curricula, but generally speaking it is possible to pass (with more or less supplementary work) from any type of secondary school to any collegiate institution and thence to any university, or to change from one type of institution or curriculum to another while passing through it.

One of the gravest problems of American instruction in mathematics, from the lowest to the highest, is that of the adequate preparation of the teachers. This is, of course, more or less of a problem everywhere, but the peculiar difficulty of American conditions will appear from a study of our reports. Suddenly, within less than two generations, a nation has been confronted with the demand for universal education. This demand would be serious enough with a population that was static as to numbers or static as to residence; but when the population has been multiplied by three, when children have been continually changing from place to place, when the school has had to teach not only mathematics but also conversational English to the children of a million immigrants a year, when the country has had not only to maintain its schoolhouses on the original territory but to provide for a million square miles besides, and when the increase in trade, in manufacture, and in wealth in general has been such as to draw its most active men into business, the solution of the educational problem has not been a simple one. Since the best type of men could not be secured in any considerable number, owing to the financial opportunities offered by a new country, since teaching was one of the few financial openings for women, and since in the earlier school years the work of the woman is more satisfactory than that of the man, there has come about a state of affairs not to be found in any of the older countries. To-day four fifths of the teachers in our elementary schools are women, and only a relatively small number remain in the profession more than a few years. The problem of training such an army of women teachers, most of whom remain in the schools but a relatively short time, has been and is one of great difficulty, and its influence upon American education in general and upon elementary mathematics in particular is serious.

The question of improving the work in arithmetic has been

much agitated during recent years, and this agitation has led to several good results. In the first place, the past quarter of a century has seen a weeding out of most of the obsolete applications of arithmetic. To-day it must be said for the subject that a large per cent of the problem material represents modern conditions of life, and is of a sufficiently varied character to meet the reasonable needs of all classes.

A second improvement of great importance has resulted from the consideration of child psychology. Apart from details of no particular significance, one feature stands out prominently—that the subject matter of arithmetic is better arranged than formerly to arouse the interest and to meet the immediate needs of a child.

A third point worthy of mention is the growing recognition of the fact that no text-book can meet all local conditions with respect to appropriate material for problems. Teachers are recognizing the value of themselves securing practical problems that represent the industries of their respective localities, both for the interest that they have for the pupils and for their value in the life of the community. With the abandonment of a number of obsolete topics during the past quarter of a century has come the possibility of reducing the time devoted to arithmetic, of supplying other topics of the modern business world, or of taking advantage of this saving of time by introducing a year of algebra and geometry. As a matter of fact, all three of these results have been partly attained.

The rapid growth of industry in recent years has had its effect upon the mathematics of the elementary schools, chiefly in respect to the nature of the topics and problems in the last two years (the seventh and eighth grades). The early occupations of the people of the country were agriculture and retail trade, and the topics of arithmetic were selected accordingly. At present the urban population is increasing much more rapidly than the rural, and industry has come to be controlled by large corporations. As a result, the agricultural problem is less in vogue, and the problem of the city and industrial type is more prominent.

The secondary schools of the United States may be classified as general and technical, the former having general culture as their primary aim, while the latter aim to prepare more or less directly and completely for certain occupations. As the technical schools have arisen largely during the past decade only,

and are of the most varied character, their diverse curricula are as yet in the earliest stages of their evolution, and the problem of the modification of the work in mathematics as found in the general schools, so as to adapt it more effectively to the purposes of the various types of technical schools, is one that now calls for careful study.

The last few decades have witnessed no thoroughgoing remodeling throughout the United States of the secondary curriculum in mathematics at all comparable with those that have taken place in several European countries. A great interest in improving the work in mathematics has recently been aroused, however, due in no small degree to the world agitation of the International Commission.

The curriculum in mathematics in secondary institutions with a full course of four years varies but little in the great majority of cases from the following average:

First year: First course in algebra.

Second year: Plane geometry begun and completed.

Third year: First half year, second course in algebra (through quadratics). Second half year, solid geometry begun and completed.

Fourth year: First half year, third course in algebra; second half year, plane trigonometry.

The courses of the first two years are usually required, the rest is usually elective.

Marked tendencies to change the curriculum in various details are distinctly noticeable in the country, and seem to be gaining in strength. Thus, there are tendencies to omit geometric proofs that are either obvious or too difficult; to transfer the more difficult portions of the algebraic matter hitherto given in the first year to a later year; to avoid algebraic manipulations of greater complexity than is requisite to prepare pupils thoroughly for the work that lies beyond; to give more prominence to the equation; and to introduce more problems from physics and other sciences and from practical life.

It has been proposed to redistribute the subject matter of algebra and geometry as now taught in the secondary schools (without altering either the ground ultimately covered or the total amount of the time given to mathematics) so that algebra and geometry should be taught simultaneously during the years in which they are now taught successively. This question, the answer to which depends largely upon the preparation of teach-

ers and other local conditions, should have serious consideration in the near future.

It has been suggested that with a little enrichment of collegiate instruction it would be possible to require the following minimum preparation for teaching in the secondary schools:

(a) Trigonometry, college algebra, analytic geometry.

(b) Surveying, or descriptive geometry, or elementary astronomy.

(c) The differential and integral calculus with applications to geometry, mechanics, and physics.

(d) Modern geometry.

(e) The elements of analytic mechanics.

(f) The elements of theoretic and laboratory physics.

(g) Algebra from a modern standpoint.

(h) One or more courses introductory to important fields of modern mathematics.

(i) One or more courses in the history of mathematics.

(j) One or more courses on the teaching of mathematics.

The requirements in mathematics with which all pupils who are to be admitted to the better colleges and technological schools of the country are to-day obliged to conform are elementary algebra through quadratic equations, plane geometry, and sometimes solid geometry. In the first collegiate year, additional algebra, trigonometry, and analytic geometry are usually successively taught. In the first course in the calculus, generally taken in the second year, the integral as the limit of a sum is introduced at an early stage, and numerous applications of the calculus to centers of gravity, moments of inertia, fluid pressures, attractions, kinetic energy, catenaries and arches, strings on rough surfaces, and the dynamics of a particle, as well as to the traditional subject of curves and surfaces—differential geometry—are taken up. It is in the course in the calculus that the convergence of infinite series and the application of power series to computation and to the development of functions are treated. This work is generally elective save in schools of engineering. The elective courses also include those courses which are usually taken just after the first course in the calculus or simultaneously with it, namely: (a) Modern geometry; (b) mechanics; (c) second course in the calculus; (d) differential equations; (e) determinants and the theory of equations. To these may be added descriptive geometry and surveying. In technological

schools some of these courses are prescribed for certain classes of students.

The purpose of advanced instruction has been well defined as fourfold:

I. To impart knowledge.

II. To develop power and individual initiative.

III. To lead the student to express adequately and clearly what he knows.

IV. To awaken the love of knowledge and to impart scholarly ideals.

Probably the advanced instruction of this country is strongest at the present time in meeting the first of these requirements. The others are not, however, wanting.

The requirements for the master's degree almost invariably consist in at least one year's work beyond a bachelor's degree granted by an institution of good standing. The work must be largely in one field, as, for example, in mathematics.

For the doctor's degree a distinctly higher requirement is enforced. In all American universities of good standing it is distinctly a research degree. In several of the stronger universities it has a standard at least as high as the best European standards.

TIME AND SPACE—A SPECULATION.

By Arthur E. Haynes,
University of Minnesota.

Time is said to be divided into the past, the present, and the future. It seems to me, however, that the present is not a division of time at all, but that it is simply the *boundary* between the past and the future.

"A limited portion of duration" is one of the definitions of time, but a limited portion must have boundaries; these boundaries, or limits, greatly vary, so it is manifest that *time* does not always involve the idea of the same amount of duration; in other words, time may mean any one of an infinite number of different periods of duration, for example: a century, a year, a month, a week, a day, an hour, a minute, a second, etc. When the limits of time are removed it becomes *eternity*.

Eternity extends infinitely *back* into the past, and infinitely *forward* into the future. The *present* is not time; it is the point from which we reckon duration in opposite directions to *infinite* extent. The present is *not* a *fixed* point, however, for while we think of it it is gone; it has instantly changed its position and lies in what was a part of the boundless ocean of the future.

The present always moves forward and not backward; what was in the present an instant ago is now in the past; it can *never* be in the future.

We cannot conceive of either eternity or the universe as having limitations. The astronomer has boldly attempted to measure the infinite

depths of space. To do this he uses as a measuring unit the *inconceivable distance light travels in one year,* at the rate of over 186,000 miles per second—the so-called "light year." He shows that some of the stars are so deeply bedded in this illimitable ocean of space that the light from them takes thousands upon thousands of years to reach us!

No more can one sound the mighty depths of eternity. As time involves the ideas of present, past, and future, so space involves the ideas of point, line, and surface. Like as time may be said to be a finite portion of eternity, so space may be said to be a *finite portion* of an infinite magnitude.

The "mighty angel" in Revelation is represented as standing with one foot upon the sea and the other upon the earth, and with uplifted hand, solemnly declaring "by him that liveth forever and ever" . . . . "that there should be time no longer." I am led sometimes to wonder when that period comes, if we shall think in eternities and, likewise, in infinities of space.

Our wonderful science of mathematics is based upon the relations of time and space.

What shall it become when the mathematician shall be able to think in terms which are infinite? His most magnificent dreams in this life may become the most sublime realities in the unending life before him! What splendid visions of the power and wisdom of God await his expanding mind, no man can even imagine or foretell!

MONAZITE AND ZIRCON.

Monazite and zircon are minerals containing rare-earth metals, whose properties on becoming incandescent when heated render them valuable in certain forms of gas and electric lights. Monazite is employed in the manufacture of incandescent gas-light mantles of the Welsbach type, and the oxide obtained from zircon enters into the composition of the glower of the Nernst electric light. Both minerals are found in the United States and have been produced to a considerable extent. During 1911, according to Douglas B. Sterrett, of the United States Geological Survey, no monazite was marketed, although 13,132 pounds of crude sand or "ore" is reported as mined in North Carolina and South Carolina.

Zircon was produced in 1911 to the amount of 3,298 pounds, valued at $802.00.

TITANIUM AND ALLOYS OF STEEL.

Much experimenting with various alloys of steel has been carried on by railroads and rolling-mill operators to produce a rail that will give more satisfactory service than the ordinary rail now in use. One of the principal metals used in these experiments, according to the United States Geological Survey, is titanium. More than 250,000 long tons of rails were rolled in 1910 from steel to which ferro-titanium had been added. More than 150,000 tons of steel rails in which nickel or nickel and chromium were used as alloy were also made during 1910, and experiments were made with about 80,000 tons of steel rails in which chromium, manganese, vanadium, and other metals were used. Certain steel makers, according to the *Survey,* are now advertising titanium steel, claiming that although no titanium is left in the steel, the removal of gases and impurities effected by it greatly increases the good quality of the steel.

THE PACIFIC COAST ASSOCIATION OF CHEMISTRY AND PHYSICS TEACHERS.

The annual meeting of this association was held Wednesday, July 31, 1912, at Berkeley, Cal., in the Chemistry Building of the University of California. The meeting was called to order at 2 P. M. by the president, Professor C. T. Wright of the University of California.

The officers elected for the ensuing year are:

President, Wm. H. Williams, Fremont High School, Oakland, Cal.

Vice-President, Clara Shira, College City, Cal.

Secretary-Treasurer, B. A. Perkins, Berkeley High School, Berkeley, Cal.

Mr. S. E. Coleman of the Oakland high school read a paper on "The Older Natural Philosophy in the Light of Modern Standards."

Professor John D. Clark of the University of New Mexico gave a model "Fire Day" demonstration and lecture, which proved very interesting. The speaker, after discussing the reason for the establishment of "fire days" in many states, carried on his lecture as if addressed to school students. He did not attempt to show all possible causes of fire but rather to give examples of each type of fire and to show the manner of extinguishing them. Following is a written outline of his lecture:

CAUSES OF FIRE:

1. *Direct Ignition*—

While lecturer is speaking an electric fan blows paper streamers into the flame of a Bunsen burner.

2. *Faint but Prolonged Heat*—

(a) Folded cloth placed on an electrically heated hot plate.

(b) An electric light bulb packed with cotton and placed in a glass jar or beaker.

3. *Spontaneous Heating*—

(a) Germinating seeds. The bulb of a very large thermometer is placed inside of a good sized Dewar bulb and the whole Dewar bulb filled with seed which has soaked in water and is ready to germinate. A plug of cotton closes the mouth of the Dewar bulb. A placard is made showing the temperature at which the thermometer stood when packed in the wet seed and space left on the card to register the temperature later read.

(b) Heat of slow oxidation. Perfectly dry cloth has about an ounce of warm boiled linseed oil onto it and the cloth rolled up tightly into the form of a cylinder which is about ten inches long and three inches in diameter. If this roll be kept perfectly dry and at a temperature of 70-80°F, it will be hot enough inside to char the cloth or cause it to burst into flame, at the end of five of six hours.

(c) Heat from absorption of gases. A jet of hydrogen is directed onto a platinum sponge and the heat of the occlusion ignites the jet. This is shown to illustrate how the heat from the absorption of oxygen may set fire to piles of charcoal, to coal piles and to sawdust dumps.

4. *Spontaneous ignition.* To illustrate the conditions of spontaneous ignition.

(a) A solution of yellow phosphorus in carbon bisulphide is poured onto a piece of paper and the paper soon bursts into flame.

(b) Phosphene prepared from yellow phosphorus and sodium hydroxide is allowed to ignite as it comes up through water contained in a glass cylinder.

5. *Explosions*—

(a) By electrolysis of water a liter flask is filled with a mixture of hydrogen and oxygen and is stoppered with a rubber cork which has two copper wires through it to act as electrodes. This flask is covered with a small wooden box. This small box is covered with a more substantial box, and the second box is covered by a third, this last being very substantial. A *violent explosion* which wrecks both the smaller boxes is produced by the spark from a coil or from a Holtz machine.

(b) Explosions of mixtures of *heavy* gases and air. A good-sized aspirator bottle is filled with the vapor of carbon bisulphide. When the bottle is opened at both necks this vapor flows *downward* into a glass cylinder and is exploded by the use of a match.

(c) Explosions of mixtures of *light* gases and air. A good sized aspirator bottle is filled with hydrogen. When the bottle is opened at both necks this hydrogen flows upward into a cylinder and is exploded by the use of a match.

6. *Electric Sparks*—

(a) A spark is passed into a gas mixture contained in a eudiometer.

(b) A small piece of fuse wire is burned by use of a heavy current.

7. *Chemical Reaction*—

Reference is made to the almost endless number of chemical reactions which produce flame or a temperature sufficiently high to cause substances to ignite.

(a) The bulb of a very large thermometer is protected by a test tube and this tube is packed in lime. When the lime slakes the mercury in the thermometer rapidly rises.

(b) Two substances which everyone has seen and with which everyone seems at least somewhat familiar: turpentine and iodine, are cautiously put together to show that chemicals are dangerous substances and that we should use the greatest care in handling those whose properties we do not know.

8. *Pressure, Friction, Shocks, etc.*

(a) The rubbing of two pieces of wood.

(b) The flint and steel.

(c) A spark from a glass rod, or other charged substance igniting gasoline vapor.

9. *Focused Rays.*—

(a) The burning glass.

(b) Air bubbles in glass objects.

(c) Hollow glassware.

Two Very Common Causes of Fires:

1. *Lighting Fires with Kerosene.*—

(a) The great danger of pouring kerosene into a stove in which there is no blaze. A pan is heated and into it some kerosene is poured and the mixture of air and kerosene vapor which forms is exploded by the use of a match.

(b) The lesser danger of pouring kerosene into a stove in which there is a blaze. A piece of cotton saturated with kerosene is set afire inside of a pan. A test tube full of kerosene is poured into this fire and no explosion results.

2. *Glowing Matches, Cigar or Cigarette Stubs in Rubbish.*

A wooden box filled with paper is behind the lecture table. An assistant pours a solution of yellow phosphorus in carbon bisulphide onto the paper and places the box on the lecture table. The lecturer lights a match, blows it out, and throws the burned match into the box. At the end of

a few minutes the contents of the box are on fire apparently ignited by the supposedly extinguished match.

Conditions which Maintain Fire:

1. Oxygen. A glowing stick is placed in a jar of oxygen.

2. Maintenance of a kindling temperature. Not demonstrated.

3. Removal of the products of combustion. A smoking kerosene lamp has the smoke confined in the chimney and at once goes out.

METHODS OF EXTINGUISHING FIRES:

1. Shutting off supply of oxygen.

(a) The woman who gets her clothes on fire and who runs out into the air is shown by saturating a roll of cloth with kerosene and waving the burning cloth through the air.

(b) The calm, cool-headed woman who wraps herself in a rug or blanket, is seen when a towel at once extinguishes the burning cloth.

2. Removing Kindling Temperature.

The use of water on a fire.

3. Choking the fire by means of a gas which won't support combustion.

(a) The principle of the small three gallon fire extinguisher is shown by putting some soda in a wide mouth bottle, and stoppering this with a two hole stopper, one hole being connected with a tube which leads to a cylinder containing a burning candle, the other hole containing a test tube full of acid. The bottom of the test tube is punched out with the end of a file, a stopper inserted in the test tube, and the carbon dioxide produced extinguishes the candle.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

The twelfth meeting of the Central Association of Science and Mathematics Teachers will be held at the Northwestern University, Evanston, on Friday and Saturday, November 29 and 30. The Great Northern Hotel, Chicago, has been selected as headquarters for out of Chicago members and friends.

The addresses at the general sessions will be given by Professor W. C. Bagley of the University of Illinois and Carroll G. Pearse, Superintendent of Public Schools, Milwaukee, Wisconsin. They will discuss some of the important phases of present-day educational problems.

The programs of the five sections contain the names of many of the prominent educators of the Middle West and provide for many reports and discussions of a practical nature which will prove of great interest and value to teachers of science and mathematics. The program of the meeting will be printed and distributed within a few days.

Persons engaged in teaching science or mathematics, or in superintending such teaching are eligible for membership. All such persons are invited to join the association. Annual dues, $2.50. In addition to membership each person will receive without further cost the monthly official journal, School Science and Mathematics, and a copy of the Proceedings, at the same time having all the advantages which come to one who is a member of a great and active association as this.

Address all communications to the Secretary-Treasurer, C. E. Spicer, 100 Sherman Street, Joliet, Ill.

PROBLEM DEPARTMENT.

By E. L. Brown,

Principal North Side High School, Denver, Colo.

Readers of this magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott Street, Denver, Colo.

Algebra.

297. *Proposed by Daniel Kreth, Oxford, Iowa.*

In what time will the compound interest on any principal at 4% equal the simple interest at 6%?

Solution by A. M. Harding, Fayetteville, Ark., and C. H. Stoutenburgh, Trenton, N. J.

Let n=number of years.

Then $1.04^n = 1 + .06n$,

or $1 + n\,(.04) + \dfrac{n(n-1)(.04)^2}{2} + \ldots\ldots\ldots\ldots = 1 + .06n.$

From this equation we find that $n=20+x$, where x is a decimal fraction.

Then $(1.04)^{20}\,(1+.04x) = 1+1.20+.06x$;

or $2.19115 + .087646x = 2.20 + .06x$;

$.027646x = .00885.$

$\therefore x = .32+$, and $n = 20.32$.

298. *Proposed by J. L. Orr, Birmingham, Ala.*

A man, standing on the rear end of a moving train, counts rail joints. When will the number of seconds or this count equal the speed of the train in miles per hour?

Solution by Philip Fitch, Denver, Colo., and L. L. Harding, Suffield, Conn.

Let l=length of rail in feet,

v=speed of train in miles per hour,

n=number of joints counted,

t=number of seconds recorded during the count.

Then $\dfrac{nl}{t}$ = speed in feet per second;

Also $\frac{22}{15}v$=speed in feet per second.

$\therefore \dfrac{nl}{t} = \dfrac{22v}{l}$. If $n=v$, $t=\frac{15}{22}l$.

Hence speed of train in miles per hour is the number of rail joints passed in $\frac{15}{22}$ l seconds — roughly, two thirds of the number of joints passed in l seconds.

299. *Proposed by Henry A. Levy, Houghton, Mich.*

Find the value of the undetermined coefficients in the expansion:

$$\frac{(4!)^3}{n^3(n+1)^3\ldots(n+4)^3} = \frac{1}{n^3} - \frac{64}{(n+1)^3} + \frac{216}{(n+2)^3} - \frac{64}{(n+3)^3} + \frac{1}{(n+4)^3}$$

$$+ \frac{A}{n(n+1)\ldots(n+4)} + \frac{B}{n(n+1)\ldots(n+3)} - \frac{90}{n(n+1)(n+2)} + \frac{C}{n^2(n+1)^2\ldots(n+4)^2}$$

$$+ \frac{D}{n^2(n+1)^2\ldots(n+3)^2} + \frac{E}{n^2(n+1)^2\,(n+2)^2} + \frac{F}{n^2(n+1)^2} + \frac{G}{n^2(n+4)^2}.$$

No solution received.

Geometry.

300. *Proposed by C. H. Stoutenburgh, Trenton, N. J.*

From a square construct a regular octagon by cutting off each corner. Prove the construction.

I. *Solution by Norman Anning, North Bend, B. C., and L. E. A. Ling, La Grange, Ill.*

To construct a regular octagon from a square, about each corner as center describe a quadrant of a circle passing through the center of the square. These quadrants cut the sides in the vertices of the required octagon.

To prove that the resulting figure is a regular octagon we must show that all its sides are equal and all its angles those of a regular octagon (135°). If we show that two adjacent sides are equal and that one angle has this value the rest will follow from the symmetry of the figure.

Each angle is supplementary to the acute angle of a right-angled isosceles triangle and is consequently $\frac{3}{2}$ of a right angle.

If the diagonal of the square is 2 the side will be $\sqrt{2}$, and any one of the "corner" triangles will have for sides $\sqrt{2}-1$, $\sqrt{2}-1$ and $\sqrt{2}\,(\sqrt{2}-1)$. The part of any side of the square left after the two corners have been cut off is

$$\sqrt{2}-2(\sqrt{2}-1)$$
$$=2-\sqrt{2}=\sqrt{2}\,(\sqrt{2}-1).$$

Hence any two adjacent sides of the figure are equal. It is consequently a regular octagon.

II. *Solution by Elmer Schuyler, Brooklyn, N. Y., and G. I. Hopkins, Manchester, N. H.*

Inscribe a circle and draw the diagonals AC and BD. These diagonals intersect in O, the center of the circle. At the points where the diagonals intersect the circle draw tangents, intersecting the sides of the square. These tangents together with their intercepts on the sides of the square form a regular octagon. Being measured by equal arcs the angles of this octagon are equal, and an equiangular polygon circumscribed about a circle is regular.

III. *Solution by W. S. Cawthorn, Pensacola, Fla.*

Let A B C D be the given square. About this circumscribe a circle. Let E, F, G, H be the mid-points of the arcs CD, DA, AB, BC, respectively. The chords EF, FG, GH, HE intersect the sides of the square in points which are the vertices of a regular octagon. Let the chord FG intersect the sides AB and AD in the points N and M, respectively; also let the chord GH intersect the sides AB and BC in the points O and P, respectively. Join B, G.

In the triangle BOG, $\angle BGO = \angle OBG = 45°$.

$\therefore BO = OG$ and $\angle BOG = \angle PON = 135°$.

Clearly the right triangles PBO and OGM are equal.

$\therefore PO = OM$.

In a similiar manner it can be proved that each angle of this octagon contains 135°, and that the sides are equal. Hence the octagon is regular.

301. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Solve without the use of trigonometric functions: The distance between the feet of two towers standing on a horizontal plane is $2a$. The angles

of elevation of their tops from the mid-point of $2a$ are complementary. The angle of the elevation of the top of the higher from the foot of the lower is double that of the top of the lower from the foot of the higher. Find the height of each tower.

Solution by T. M. Blakslee, Ames, Iowa, and M. W. Grene, Saguache, Colo.

Let x be height of shorter tower and $x + y$ that of longer.

From similiar triangles,

$$x : a = a : x + y \text{ or } x^2 + xy = a^2 \quad (1)$$

A line from the base of the shorter tower to a point x feet above the base of the other bisects the angle of elevation of the higher tower.

$\therefore x : y = 2a : [4a^2 + (x+y)^2]^{\frac{1}{2}}$
or $4a^2x^2 + x^2(x+y)^2 = 4a^2y^2$ (2)
From (1) and (2), $4a^2x^2 + a^4 = 4a^2y^2$,
from which $y^2 - x^2 = a^2/4$. (3)
From (1) and (3), $y^2 + xy = 5a^2/4$. (4)
From (1) and (4), $(x+y)^2 = 9a^2/4$
$\therefore x+y = \pm 3a/2$ (5)
From (1) and (5), $x = \pm 2a/3$
$\therefore$ The heights of the towers are $2a/3$ and $3a/2$.

302. *Proposed by Norman Anning, North Bend, B. C.*

With a given number of trees per acre of orchard, how much farther apart may they be placed by using the equilateral triangular plan instead of the square?

Solution by the Proposer.

Let a be the distance between neighboring trees for the equilateral triangular arrangement and b for the square. In the first case there is for each tree an area of a regular hexagon of side $\frac{a}{\sqrt{3}}$ which is the same as the area of two equilateral triangles of side a, i. e., $\frac{a^2\sqrt{3}}{2}$. In the second case there is for each tree a square of side b; area b^2. We wish to compare a and b when these areas are equal.

$$\frac{a^2\sqrt{3}}{2} = b^2. \quad \therefore \frac{a^2}{b^2} = \frac{2}{\sqrt{3}} \text{ and } \frac{a}{b} = \sqrt{\frac{2}{\sqrt{3}}} = 1{\cdot}0746 \ (=\tfrac{14}{13} \text{ nearly}).$$

II. *Solution by C. H. Stoutenburgh, Trenton, N. J.*

Let a^2 = no. of trees per acre.

In square plan,

No. rows $= a$,

Dist. between trees $= \dfrac{\text{side of one acre}}{a} = \dfrac{208.7}{a}$ feet.

In triangular plan,

Side of $\triangle$ acre $= 317.2$ feet.

The no. of trees in last row is the last term of an arithmetic series whose sum is a^2, first term one, and in which the number of terms equals the number of the last term.

In $s=\frac{n}{2}(a+l)$ substitute l for n and a^2 for s and solve for l:

$$l=\tfrac{1}{2}\sqrt{8a^2+1}-\tfrac{1}{2}$$

Considering unity in $8a^2+1$ as negligible,

$$l=a\sqrt{2}-\tfrac{1}{2}=a\sqrt{2}, \text{ approximately.}$$

$\therefore$ distance between trees $=\dfrac{317.2}{a\sqrt{2}}$.

Ratio of distances $=\dfrac{317.2}{a\sqrt{2}} \Big/ \dfrac{208.7}{a}=1.0746+$.

CREDIT FOR SOLUTIONS RECEIVED.

297. N. Anning, A. M. Harding, Elmer Schuyler, C. H. Stoutenburgh. (4)
298. Norman Anning, Philip Fitch, L. L. Harding, Kenneth E. Reynolds. (4)
300. Norman Anning, T. M. Blakslee, W. S. Cawthorn, M. W. Greene, L. L. Harding, G. I. Hopkins, L. E. A. Ling, Effie Morse, C. H. Stoutenburgh, Elmer Schuyler. (10)
301. Norman Anning, T. M. Blakslee, W. S. Cawthon, M. W. Greene, A. M. Harding, G. I. Hopkins, L. E. A. Ling, Kenneth E. Reynolds, Elmer Schuyler, C. H. Stoutenburgh. (10)
302. Norman Anning, C. H. Stoutenburgh. (3)

Total number of solutions, 31.

PROBLEMS FOR SOLUTION.

Algebra.

313. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

Solve:

$$x^3+y^3-z^3-u^3=133. \quad (1)$$
$$x^2+y^2-z^2-u^2=15. \quad (2)$$
$$x+y-z-u=1. \quad (3)$$
$$xy=zu \quad (4)$$

314. *Proposed by H. E. Trefethen, Waterville, Me.*

A piece of land in the form of a triangle ABC increases in value from the vertex C toward the base in proportion to the nth power of the distance from a line through C parallel to AB. Divide it by lines parallel to the base among m men so that they each have shares of equal value.

Geometry.

315. *Selected.*

Construct a triangle, given its pedal triangle.

316. *F. Eugene Seymour, Trenton, N. J.*

Through a point within a given angle to draw a line which will form with the given sides of the angle a triangle of minimum area.

317. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Given two circles of radii 2 and 9 respectively and the sect 14 between their centers; also the common external tangents. If the figure is made to rotate about 14 as an axis find the volume generated by the entire figure and the area generated by the two tangents and the two arcs not between the two centers.

REQUEST: A new supply of interesting and instructive problems is desired for this department.—ED.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer the questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School Cleveland, O.*

HARVARD UNIVERSITY, NEW PLAN, PHYSICS.

(One Hour and a Half.)

Omit four questions. All note-books must be handed in at the laboratory examination and must be claimed when it is over.

In all cases where numerical answers are given, the units in which they are expressed, and course of reasoning leading to them, should be indicated.

91. A gas main runs up a hill 100 meters high. When no gas is flowing, the pressure in the main at the bottom of the hill is 8 grams per square centimeter in excess of the pressure of the surrounding air. What would be the difference between the pressure in the main and that of the surrounding air at the top of the hill under the same conditions? Assume that the average densities of the two columns are as follows: air, 0.0012 grams per cubic centimeter; gas, 0.0003 grams per cubic centimeter.

2. A uniform gate 4 feet long and 3 feet high weighs 75 pounds and is supported by hinges at its upper and lower left hand corners. Find the horizontal force exerted on the gate by each hinge.

3. The stiffness of a beam of given length is proportional to its width and to the cube of its vertical thickness. Which would be stiffer as a floor beam in a house, an old-fashioned beam 6 inches square, or a plank containing only half as much material, but of cross section 2x9 inches and set on edge? Give numerical values.

92. About 100,000,000 tons of water go over Niagara Falls every hour, and drop 161 feet. If all this water were run through a power house of 75 per cent efficiency, how many horse-power would be available?

5. A balloon is floating over a fort at a height of 10,000 feet.

(a) With what velocity must a shot be fired vertically upward in order to reach the balloon?

(b) How many seconds will it take the shot to reach the balloon?

N.B.—Neglect the air resistance, although it would be large in the actual case.

6. (a) Does the velocity of sound in the open air vary from day to day, and if so, why?

(b) A locomotive known to be going 60 miles an hour, whistles at a crossing. If the sound is heard by someone 5 miles down the track 27.6 seconds before the locomotive reaches him, what is the velocity of sound at the time?

7. What do you think heat is, and why do you think so?

93. Two kilograms of food at 90°C. (specific heat 0.5) are put into a refrigerator and cooled to 10°C. all of the heat going into the ice. How much ice is melted, if the water formed escapes at once?

9. A lamp *A* illuminates a wall twice as much as a lamp *B* does, when *B* is three times as far from the wall as *A* is. Compare their illuminating powers at equal distances.

10. A luminous point is 60 centimeters in front of a spherical mirror, and its image is found to be 20 centimeters from the mirror on the same side.

(*a*) Is the mirror convex or concave?

(*b*) What is its focal length?

11. Describe, with a simple diagram:—

(*a*) A series wound electric motor.

(*b*) A shunt wound electric motor.

94. A "hylo" incandescent electric light bulb is provided with a switch by which the electric current can be sent through a low-resistance filament for giving a bright light, or through a high resistance filament for giving a feeble light. The lamp operates on a 110-volt circuit, and the resistances of the two filaments are 220 ohms and 1100 ohms respectively. If the cost for electric power is half a cent per hour when the low resistance filament is used, what is the cost per hour when the high resistance filament is used, and what is the rate per kilowatt-hour that is being paid for power? The phrase "per kilowatt-hour" means "per hour for each 1000 watts taken."

CHEMISTRY.

(One Hour and a Half.)

All note-books must be handed in at the laboratory examination, and must be claimed when it is over.

Candidates should answer the first five questions, and should then select five from the remaining questions.

1. Give several physical and chemical tests by which you could distinguish between silver, sodium, and zinc.

2. Write the following equations in complete form, using formulæ:—

(*a*) Manganese dioxide + hydrochloric acid = ?

(*b*) Calcium hydroxide + carbon dioxide = ?

(*c*) Barium nitrate + ammonium sulphate = ?

95. Five grams of silver chloride can be obtained by adding silver nitrate to a certain amount of crystallized calcium chloride, $CaCl_2 \cdot 6H_2O$. What is the weight of the calcium chloride?

$H = 1 \quad O = 16 \quad Cl = 35.5 \quad Ca = 40 \quad Ag = 108$

4. (*a*) State Gay Lussac's Law of Combining Volumes.

(*b*) Illustrate this law with two examples.

5. (*a*) Discuss the composition of acids.

(*b*) Mention not less than three wholly different ways to test for an acid.

6. A liter of nitrous oxid and one of ammonia are weighed at 100°C. and 700 mm. If the nitrous oxide weighs 1.33 grams, how much will the ammonia weigh?

$H = 1 \quad N = 14 \quad O = 16$

7. Under what circumstances will chemical reactions run to an end? Illustrate each case with an example.

8. Describe and explain an experiment for determining quantitatively the solubility of some particular salt in water.

9. (*a*) Describe the properties of radium compounds.

(*b*) In what respect does radium differ from most other elements?

10. (*a*) What kinds of impurities may drinking water contain?

(*b*) Which of these are harmful to health?

(*c*) Explain how unwholesome water may be improved.

11. State briefly how each of the following three substances may be obtained free from impurities, starting from the source mentioned:—

(*a*) Copper from copper sulphate.

(*b*) Sulphuric acid from sulphur dioxide.

(*c*) Potassium sulphate from potassium chloride.

12. Describe three allotropic forms of sulphur, giving the name of each, and stating how each may be made.

13. Describe a process for the extraction of iron from its ores. (Use a diagram.) June, 1912.

QUESTIONS AND PROBLEMS FOR SOLUTION.

96. *Proposed by C. A. Perrigo, Dodge, Neb.*

The record for baseball throwing is about 400 ft. What was the velocity with which the ball left the hand? (Hastings and Beach, General Physics, page 67.)

Answer serially numbered questions in the following lists:

SOLUTIONS AND ANSWERS.

82. A body whose specific gravity is 7.6 weighs 54.6 grams. What will it weigh in water? What will it weigh in oil whose specific gravity is 0.9? What is the volume of the substance?

Answer by C. A. Smith, Oakland, Iowa.

(*a*) $$D = \frac{\text{weight in air}}{\text{loss of weight in water}} \text{ or } \frac{m_a}{m_a - m_w}$$

$$\therefore 7.6 = \frac{54.6g}{54.6_g - m_w}\,;\ m_w = \overline{414.96 - 54.6} \div 7.6 = 47.4g/cc$$

(*b*) $$7.6 = \frac{54.6g}{54.6 - .9m_w}\,;\ m_w = \overline{414.96 - 54.6} \div 6.84 = 52.7g/cc$$

(*c*) $54.6^g - 47.4^g = 7.2cc.$ volume.

83. Forty voltaic cells in series are sending a current of one ampere through a coil of 22 ohms resistance. The resistance of one cell is 0.55 ohm. What is the E. M. F. of one cell?

Answer by C. A. Smith, Oakland, Iowa.

$$I = \frac{nE}{R + nr}$$

$$1 \text{ amp.} = \frac{40E}{22 + 40 \times .55} = 1.1 \text{ volt E. M. F.}$$

FEDERAL MEAT INSPECTION.

A few months ago attention was called to the fact that the borax trust and other interests unfriendly to Dr. Wiley, in criticising the ex-chief of the Bureau of Chemistry, took occasion to laud the Bureau of Animal Industry. The latter bureau has charge of examining the meat supplies of the country, and the argument of the Anti-Wiley forces was that, while the Bureau of Chemistry has had a somewhat stormy career, the Bureau of Animal Industry was conducted "without friction." It was suggested at the time that any department of government service, supposed to be operated in the interest of the public, which got along "without friction" was to be viewed with suspicion. Recent developments

seem to *The Journal of the American Medical Association* to point to the source of the lubricant which has permitted the Bureau of Animal Industry to operate without any friction developing between themselves and the vested interests concerned. The Bureau of Chemistry has, it is true, been much criticised in the last four or five years—but the criticisms have come not from the consumers, but from the manufacturers. Now the Bureau of Animal Industry is coming in for its share of criticism, but with this difference, that representatives of the consumer and not of the packing houses are the critics. Charges have been made by competent and unbiased observers that the federal meat inspection laws are administered in the interest of the packers rather than for the protection of the public, and that meat that would not be accepted at the ports of entry in Europe is passed by the federal meat inspectors for home consumption. As might be expected, the investigation of the Bureau of Animal Industry exhibits Secretary Wilson and Solicitor McCabe "running to form" as special pleaders for the "interests." The enormous harm done to the health of the American people through the maladministration of the Food and Drugs Act and the federal meat inspection law can hardly be estimated. The responsibility for it rests on Secretary Wilson and Solicitor McCabe, whose incompetency—or something else—has rendered the enforcement of these laws a joke.

SALT AIR, SUNSHINE AND CLIMATE.

The significance of climate as a factor in the treatment of disease is generally conceded. Altitude, sunshine, salt air, ocean breezes and forest hills are expressions with which the practitioner now and then attempts to conjure his jaded patients. Not infrequently the spell is effective, bringing with it a renewal of vigor and restoration of health. Can objective causes for climatic influences be discovered? What are the reasons for the frequently observed beneficial effects of an ocean voyage, or a stay at the seaside? Professors Zuntz of Berlin and Durig of Vienna—both well-known European experts in physiology, who have devoted much energy to the study of the effects of high altitudes on man—have given some consideration to these questions. In the course of an ocean voyage from Germany to the Canary Islands and return they made careful observations on pulse-rate, body temperature, etc. Despite the invigorating nature of the trip these fundamental bodily features were not found altered in any detectable uniform degree. This corresponds with what has been observed in investigations at seaside resorts where the travel factor is excluded, but the atmospheric conditions are similar in many ways, says *The Journal of the American Medical Association.* Neither such conditions, nor the tropics, nor yet polar climates effect any marked alteration in these physiologic functions. In any event it has been impossible to demonstrate changes that might be considered indicative of a stimulating effect of ocean climates. A similar outcome has attended the careful experimental investigation of the effect of sunlight. An abundance of direct sunlight, especially in some of the widely visited health resorts, has always claimed a due share of the credit ascribed to the invigorating climate. We read of the days of balmy sunshine. Careful scientific observations have not disclosed any bodily changes due to this cause. Notwithstanding all of these negative findings, however, no one can deny the usefulness of a change of climate, despite the obscurity surrounding the secret of its influence on the individual.

ARTICLES IN CURRENT PERIODICALS.

Condor for July-August: "Birds of the Cottonwood Groves," with two photos, Florence Merriam Bailey; "Notes on the Wading Birds of the Barr Lake Region, Colorado," with thirteen photos, Robert B. Rockwell; "The Present and Future Status of the California Valley Quail," with map and diagram, Harold C. Bryant; "A Journey to the Star Lake Country and Other Notes from the Tahoe Region," with three photos, Milton S. Ray; "The Present Status of the Colorado Check-List of Birds," Wells W. Cooke.

Educational Psychology for September: "Graded Mental Tests," Part I, Attention, Perception, Comprehension and Memory, Carrie Ransom Squire; "A Study in the Psychology of Spelling," Linus W. Kline; "Some Observations on the Learning of Sensible Material," John A. Dell.

L'Enseignement Mathématique for July: "Sur la génération des courbes unicursales," Ch. Tweedie; "Sur les dyads et les dyadics de Gibbs," C. Burali-Forti et R. Marcolongo; "Définition des fonctions trigonométriques par leur théorème d'addition," H. Scheupp; "Noveau procédé pour le dévelopment des fractions décimales périodiques simples," Léon Pasternak.

Mathematical Gazette for July: "The Cambridge School of Mathematics," W. W. Rouse Ball; "The Theory of Proportion," Professor M. J. M. Hill; "The Power-Sum Formula and the Bernoullian Function," W. F. Sheppard; "Mathematical Notes."

Nature-Study Review for September: "Nature Study and Elementary Agriculture," Anna Botsford Comstock; "Wild Flower Gardening," Frank C. Pellett; "Insect Life of Pond and Stream," Part III, Paul S. Welch; "Hygiene as Nature Study," Part I, F. M. Gregg; "Observations on a Pair of Nesting Song Sparrows," Ralph E. Wager.

Popular Astronomy for October: "Astronomy at Pittsburgh," with plate; "Jupiter, 1912," with plate, Latimer J. Wilson; "The Discovery of Neptune," David Rines; "A Great Solar Outburst," with plate, Alfred Rordame; "The Stellar Universe in the Light of Recent Investigations," Hector Macpherson, Jr.; "Variability of Polaris," Edward S. King.

Popular Science Monthly for September: "Research in Medicine," Richard M. Pearce; "Wind-graved Meses and their Message," Charles R. Keyes; "Old Lamps for New," John Mills; "The Revival of Economic Orthodoxy," S. M. Patten; "George Marcgrave, the First Student of American Natural History," E. W. Gudger; "The Real Problem of Commission Government," Oswald Ryan; "Genius and Hair Color," Charles Kassel; "The Nature of Hunger," W. B. Cannon.

Popular Science Monthly for October: "The Guayule—A Desert Rubber Plant," F. E. Lloyd; "Rosseau's Contribution to Psychology, Philosophy, and Education," W. B. Pillsbury; "Smoking and Football Men," Frederick J. Pack; "The Minister's Son," Rev. Clarence Edward Macartney; "History-making Forces," Frank T. Carlton; "Industrialism," Charles S. Slichter; "The Inheritance of Fecundity," Raymond Pearl; "Stuffy Rooms," Leonard Hill; "The Permanent Fireproofing of Cotton Goods," William Henry Perkin.

School World for September: "Teachers and Educational Research," T. Raymont; "The Question of Sequence in Geometry," Charles Davison; "The Use of Practical Exercises in the Teaching of Geography," J. Martin; "The Place of Grammar in the Teaching of English," W. Murison; "Original Sources in the Teaching of History," A. J. B. Green.

Scientific American Supplement for August 17: "The Manufacture and Applications of Nitrous Oxide," four illustrations, A. S. Newmark; "How to Make Quartz Fiber," two illustrations, C. C. Hutchins; "Welding by Electricity," four illustrations; "The Correlation Between Sun Spots and the Weather," A. Gockel; "Surface Combustion," ten illustrations, W. A. Bone; "The Preservation of Our Fish Supply," one illustration, George Carroll Curtis.

Scientific American Supplement for August 24: "A Review of the Physics of Light," I, Prof. Silvanus P. Thompson; "Tracing Wild Animals by the Spore," one illustration; "The Light Quantity Hypothesis," D. F. Comstock; "Trisecting a Given Angle," five illustrations, Felix Alexander Joseph; "Cyrenaica," five illustrations; "Manufacture and Treatment of Steel for Guns," two illustrations, General L. Cubillo.

Scientific American Supplement for September 10: "The Manufacture of Chili Saltpeter," eight illustrations, B. Diaz-Ossa; "A Museum of Underground Life," seven illustrations; "The Second Law of Thermodynamics," Charles P. Steinmetz; "Damming the World's Greatest River," eleven illustrations, H. S. Rogers; "The Chemical and Mechanical Relations of Iron, Vanadium, and Carbon," six illustrations, Prof. J. O. Arnold; "The Cryogenic Laboratory at Leyden," three illustrations, G. Bresch; "The Production of Ethyl Alcohol from Waste Products," Alcon Hirsch.

Unterrichtsblätter für Mathematik und Naturwissenschaft, Nr. 5: "Zur Reform des Rechenunterrichts," Dr. E. Bungers; "Wie können Schüler selbständigen mathematischen Arbeiten angeregt werden?" Prof. Dr. Hubert Müller; "Ueber eine Sterbetafel für den Unterricht," Prof. Dr. R. Gerhardt; "Quadrattafel der Zahlen von 1 bis 1000," Dr. Th. Arldt; "Die Binomialreihe," Prof. Milarch; "Anschauliche Summation geometrischer Reihen," Dr. H. Böttcher.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht for July: "Ueber die Anlage zur Mathematik," Christian Beyel; "Eine zu beanstandende Aufgabe aus dem Richnen," P. Biedermann; "Eine optische Beziehung zwischen Kreis und Kardioide," Prof. Dr. Th. Meyer; "Zur Reformbewegung auf dem Gebiete des mathematischen und naturwissenschaftlichen Unterricht," redigiert von Dr. W. Lietzmann; "Zur Geometrographie," redigiert von K. Hagge.

DANGERS IN THE CELLULOID INDUSTRY.

That the peril of celluloid working is not confined to its inflammability alone, is pointed out in the new regulations in regard to the working and finishing of celluloid articles, issued by the Ministry of Saxony. According to a statement accompanying these regulations, there is also the danger of poisoning by prussic acid, which is produced when celluloid burns. Experiments, made by the Hygienic Institute at Leipzig, have shown that 5 grammes of celluloid scraps ignited in the open air will produce about 0.05 grammes of prussic acid, a quantity sufficient to kill one person. The danger is increased when celluloid working is done in the small rooms of private dwellings with insufficient ventilation. The new regulations forbid the manufacturers to give out more than 13 pounds of material at a time to any one family employed in home finishing, and also they are to point out to these people the danger connected with this work.—*Scientific American Supplement.*

LEADS WORLD IN ASBESTOS MANUFACTURE.

In 1911 the United States excelled all other countries of the world in the conversion of raw asbestos into manufactured products, but a very small percentage—less than 1 per cent of the asbestos used—was mined in this country, by far the larger part being imported from Canada. The total production in the United States for 1911, according to the United States Geological Survey, was valued at $119,935; the raw material imported from Canada was valued at more than eleven times that amount. Canada's production of asbestos in 1911 was worth nearly $3,000,000.

IRON IN PLANTS.

Experiments are under way at the agricultural bacteriological station at Vienna to increase the quantity of iron carried in certain plants, with a view to the effect on the human system when those plants are used as food. Artificially prepared foods containing iron do not always produce the desired effect, because the iron is not completely assimiliated. This difficulty, it is thought, may be avoided by causing plants to take up an increased quantity of iron during their natural growth. By adding hydrate of iron to the soil in which it was growing, the experimenters have succeeded in producing spinach containing a percentage of iron seven times as great as that found in the ordinary spinach. It is believed that the process will prove successful with other ferruginous plants.

ORIGIN OF COLORS IN YELLOWSTONE PARK.

That the harmonious and brilliant tints in the geysers and hot-spring pools are due mainly to plant life is one of the interesting statements made in a publication entitled "The Geological History of Yellowstone National Park," just issued by the Department of the Interior. Algae flourish equally well in the waters of all geyser basins and on the terraces of Mammoth Hot Springs. Wherever these boiling waters cool to the temperature of 185 degrees algous growths appear, and by the lowering of the temperature on exposure to air still more highly organized forms gradually come in. It is said that at about 140 degrees the conditions are favorable for the rapid growth of several species. The development of plant life at such excessive temperatures and on a scale of such magnitude seems a marvelous thing. Nowhere else can this be seen so well as in the Yellowstone Park.

As the waters in shallow pools chills rapidly, corresponding changes in color follow. No life exists in the center, where the water is boiling. On the outer edge certain colors prevail, and in the cooler overflow channels still other colors predominate. In a geyser basin, the first evidence of vegetation in an overflow stream consists of creamy white filamentary threads passing into light flesh tints and then to deep salmon. With distance from the source of heat, the predominating colors pass from bright orange to yellow, yellowish green, and emerald, and in the still cooler waters various shades of brown.

The marvelous colors in the Grand Canyon of the Yellowstone are mainly due to mineral matter, the pigments being derived from the lavas. Along the base of the canyon thermal and solfataric agencies have been at work through long ages, slowly but steadily decomposing the rhyolite rock that forms the walls. Upon the buttressed walls and sculptured amphitheaters tints of green and yellow are intermingled with red, the colors being blended with singularly harmonious effects. From the roaring turbulent river at the bottom to the somber green forces at the top, the abrupt walls seem aglow with color.

This publication contains an account of the geologic forces that have caused the wonderful natural features that have made the Yellowstone famous throughout the world. It is illustrated by photographs of some of the principal features of the park and is written in nontechnical language so that it may be readily understood by persons without scientific training.

SPITZBERGEN AS A SCIENTIFIC PRESERVE.

Diplomatic negotiations regarding Spitzbergen, now in progress, contemplate the unique plan of setting aside this far northern archipelago as a sort of happy hunting ground for scientific men. According to this plan, no land can hereafter be acquired in Spitzbergen except for purely scientific or humanitarian purposes, and the further exploitation of land already in the possession of commercial organizations (mines, fisheries, etc.) will be placed under such restrictions as will ensure the preservation of the flora and the fauna. The hunting of fox, polar bear, walrus, and reindeer will be prohibited from May 1 to September 15. The hunting of eider-duck will be prohibited entirely, as also the use of poisons and explosives in fishing.

A VOLCANO THAT BECAME A LAKE.

Unique among the natural wonders of America is the lake in Crater Lake National Park in Oregon, which is described in a publication entitled *Geological History of Crater Lake* just issued by the Department of the Interior. The traveler who, from the rocky rim of the lake, looks across its limpid waters to the cliffs beyond stands where once the molten lava of Mount Mazama boiled and seethed in its efforts to find an outlet, for Crater Lake is all that remains of a great volcano that ages ago reared its lofty summit high above the crest of the Cascade Range.

Before the Cascade Range existed the region now included in the State of Oregon was a great lava plateau that extended from the Rocky Mountains to the present Coast Range. Gradually mountain-making forces became operative; the surface of the plateau was arched and there rose the great mountain system which is now known as the Cascade Range. With the hardening of the crust the centers of eruptions became fewer until they were confined to a few high mountains that were built up by the flows of molten lava. In this way were created Hood, Rainier, and Mazama, from whose sides and lofty summits streams of lava poured across a desolate land. Hood and Rainier still lift their snowy caps to the clouds and fling a defiant challenge to the mountaineer to scale their steep, ice-covered slopes. Mazama alone is gone, engulfed in the earth from which it came. In what is left of its caldera lies Crater Lake.

Mount Mazama in its prime rose to a height of over 14,000 feet above the sea. Mount Scott, which towers above Crater Lake on the East, was only a minor cone on the slope of Mount Mazama. The portion of the mountain that has been destroyed was equal in size to Mount Washington in New Hampshire and had a volume of 17 cubic miles.

From the crest of the rim surrounding the lake the traveler beholds 20 miles of unbroken cliffs which range from 500 to nearly 2,000 feet in height. The clear waters of the lake reflect the vivid colors of the surrounding walls and whether in the soft glow of the early morning, in the glare of the noonday sun, or in the rosy hues of the dying day, the view is one of awe-inspiring grandeur and beauty.

This publication contains a detailed account of the formation of this wonderful work of nature. It is well illustrated by photographs and is written in nontechnical language so that it may be readily understood by the reader who has not the advantage of scientific training.

BOOKS RECEIVED.

General Science, by Bertha M. Clark, William Penn High School, Philadelphia. 363 pages. 13x19 cm. Cloth, 1912. American Book Company, New York.

Agricultural Education in the Public Schools, by Benjamin M. Davis. Pages vi+163. 16x23 cm. 1912. University of Chicago Press.

Elements of Plane Trigonometry and Tables, by Daniel A. Murray, McGill University. Pages ix+231. 13x21 cm. Cloth, 1911. $1.00 net. Longmans, Green & Co., New York City.

Catalogue M. Physical and Chemical Apparatus. 486 pages. 17x25 cm. Paper, 1912.

Catalogue K. Physical Apparatus for Universities and Colleges. 179 pages. 17x25 cm. Paper, 1912.

Catalogue O. Lantern Slides. 74 pages, Paper, 1912. Central Scientific Company, Chicago.

Report of the Illinois State Museum of Natural History, for 1909-10, by A. R. Crook, Curator. 557 pages. 16x22 cm. Cloth. Illinois State Journal Company, Springfield.

Superintendents and Principals' Association of Northern Illinois, Seventh Year Book. 39 pages. Paper, 1912. The University of Chicago Press.

College Engineering Notebook for Classes in Technical Schools and Colleges, by Robert E. Moritz, University of Washington. Pages 19+100 sheets coördinate paper. 22x26 cm. Ginn & Co., Boston.

Lessons in Physics, a Manual for Laboratory and Class Work, by Herbert Brownell, Teachers College, University of Nebraska. 132 pages. 15x22 cm. Cloth, 1912. 50 cents. The Torch Press, Cedar Rapids, Iowa.

Medical Education in Europe, a report to the Carnegie Foundations, by Abraham Flexner. Pages xx+357. 18.5x25 cm. Paper, 1912. The Carnegie Foundations, 576 Fifth Avenue, New York.

Report of the New York State Veterinary College, by President Jacob Gould Schurman, and Director Veranus A. Moore, 220 pages. 14x21 cm. Paper, 1911. J. B. Lyon Company, Albany.

Elementary Entomology, by E. Dwight Sanderson, West Virginia University, and C. F. Jackson, New Hampshire College. Pages v+322. 15x21 cm. Cloth, 1912. $2.00. Ginn & Co., Boston.

Plane Geometry, by William Betz, East High School, Rochester, and Harrison E. Webb, Manual Training High School, Newark. Pages x+332. 13x19 cm. Cloth, 1912. Ginn & Co., Boston.

Work and Play with Numbers, by George Wentworth and David Eugene Smith. 144 pages. 14x19 cm. Cloth, 1912. 35 cents. Ginn & Co., Boston.

Descriptive Catalogue of High School and College Text-books. Pages, xxxv+507. 14x19 cm. Cloth, 1912. American Book Company, Chicago.

Comparative Anatomy of Vertebrates, by J. S. Kingsley, Tufts College. Pages ix+401. 16x23 cm. Cloth, 1912. $2.25 net. P. Blakiston's Sons & Co., Philadelphia.

Energy System of Matter, by James Weir. Pages, ix+200. 15x23 cm. Cloth, 1912. Longmans, Green & Co., New York.

Complete School Algebra, by Herbert E. Hawkes, Columbia University, William A Luby, Central High School, Kansas City, Mo., Frank C. Touton, Central High School, St. Joseph, Mo. Pages, ix+507. 13x19 cm. Cloth, $1.25. Ginn & Company, Boston.

Catalogue Morgan Park Academy, Morgan Park, Ill. 88 pages. 20x26 cm. Illustrated. Paper. 1912-13.

The Francis W. Parker School Year Book, Chicago, by the faculty. 139 pages. 15x23 cm. Paper. 1912.

Bulletin of the University of Texas. Chemistry in High Schools, by E. P. Schoch. 117 pages. 15x23 cm. Paper. 1912. Published by the University at Austin.

A Text-Book of Human Physiology, including a section on Physiologic Apparatus. By Albert P. Brubaker, Jefferson Medical College. Fourth edition revised and enlarged. Pages xii+736. 377 illustrations. 17x24 cm. Cloth. 1912. $3.00 net. P. Blakiston's Son & Co., Philadelphia.

Toys and Toymaking. By George F. Johnson. 160 pages. 14x22 cm. 98 plates. Cloth. 1912. Longmans, Green & Co., New York.

Materials and Construction. By James A. Pratt. Pages xi+196. 13x18 cm. 85 illustrations. Cloth. 1912. 90 cents net. P. Blakiston's Son & Co., Philadelphia.

New Analytic Geometry. By Percey F. Smith, Yale University, and Arthur S. Gale, University of Rochester. Pages x+342. 13x19 cm. Cloth. 1912. Ginn and Company, Boston.

Mathematical Wrinkles. By Samuel I. Jones, Gunter College. Pages viii+321. 13x19 cm. Cloth. 1912. $1.65 net. Samuel I. Jones, publisher, Gunter, Tex.

Elementary Applied Chemistry. By Lewis B. Allyn, Normal School, Westfield, Mass. Pages xi+127. 13x19 cm. Cloth. 1912. Ginn and Company, Boston.

The Elements of Geography. By Rollin D. Salisbury, Harlan H. Barrows, and Walter S. Tower, University of Chicago. Pages ix+616. 14x20 cm. Cloth. 1912. Henry Holt & Co., New York.

First Year Algebra. By Webster Wells and Walter W. Hart. University of Wisconsin. Pages vii+321. 12x18 cm. Cloth. 1912. D. C. Heath & Co., Boston.

A Primer on Alternating Currents. By W. G. Rhodes, Technical Institute, Salford, England. Pages viii+145. 13x19 cm. Cloth. 1912. Longmans, Green & Co., New York.

Essentials of Physics. By George A. Hill, Harvard University. Pages viii+344. 14x19 cm. Cloth. 1912. Ginn and Company, Boston.

Health in Home and Town. By Bertha Millard Brown. Pages vi+312. 15x19 cm. D. C. Heath & Co., Boston.

Shop Mathematics. By Earle B. Norris and Kenneth G. Smith, University of Wisconsin. Pages xi+187. 16x24 cm. Cloth. 1912. $1.50 net. McGraw-Hill Book Company, New York.

BOOK REVIEWS.

Laboratory Experiments in Chemistry, by B. W. Peet, Normal College, Ypsilanti, Mich. Sixth edition revised. 1912. Geo. Wahr, Ann Arbor, Mich.

In this edition Part I has been quite largely rewritten, some experiments have been omitted and several new ones added. The experiments on ionization have all been changed and increased in number. Several experiments that deal with everyday life, domestic science, and testing substances used in the household have been introduced. These changes make this excellent manual strictly up to date, practical and usable. It is one of the best manuals on the market. C. M. T.

Guide to the Systematic Use of the North American Bird and Nature Study, a Manual of Reference, by Harold B. Shinn, A.M., Instructor in Zoölogy, Schurz High School, Chicago, and Gerard Alan Abbott. Pages 459. 12 mo. Cloth, 1912. Published by John C. Mountjoy.

This book was written to accompany the well-known birds and nature series of charts published by Mr. Mountjoy, but is worthy of standing on its own footing as a book of reference. Following an introductory chapter on nature study method and the use of charts, the contents of the book are divided into two parts. The first part of about seventy pages consists of a series of essays by Mr. Shinn on the "Factors of Animal Life." The topics for these essays are well chosen—some of them may be noted —"Homes of Animals and How They Protect Themselves;" "The Colors of Animals;" "Parasitic and Social Habits of Animals," etc. These subjects are treated in an interesting and familiar manner in untechnical language which may be readily understood by the average elementary school teacher or even by the school children.

Part II was written partly by Mr. Abbott and partly by Mr. Shinn, Mr. Abbott taking the birds and plants and Mr. Shinn taking other miscellaneous animals by groups as given on the charts. The birds are described individually. These descriptions include various items on the habits, nesting, and songs of the various birds. There is no description of plumage. These descriptions contain much information of a cyclopædic character and no doubt will be useful to those who have the charts. The descriptions signed by Mr. Shinn have a more personal touch and are accompanied by suggestive questions. Taken as a whole the book is well donç and will prove helpful to possessors of the series of charts—especially for those without libraries for reference.

W. W.

Elementary Algebra, Second Course, by John C. Stone and James F. Millis. Pages v+257. 15x20 cm. 1912. Benj. H. Sanborn & Co., Boston.

This book completes a series of high school text-books which will have great influence in making algebra and geometry of more practical value to pupils. In all of the books of the series there is plenty of material for teachers who still feel that they must make mental discipline or preparation for college their chief aim. But the distinguishing feature of the series is the purpose to furnish high school pupils with a scientific instrument for solving certain types of problems actually encountered in the world's work.

The Second Course gives a brief review of the topics treated in the First Course, adds new material where necessary, and includes all topics required for admission to college. In the exercises other letters than x, y, and z are used, and there are plenty of simple literal expressions for drill in processes and manipulation. The problems are new and many of them are based on geometry, on simple principles of physics, on business transactions, or on affairs of daily life within the experience of the pupil.

Graphical methods are used with discrimination. They are found where they should be, throughout the book to illustrate principles and to solve problems. A chapter on graphs, set off by itself and never used by the author in any other part of the book, is of little value. At the end of each chapter are supplementary exercises which may be used for review or to adapt the work to the needs of particular classes. The table of square roots and cube roots is a valuable addition. H. E. C.

Catalogue of High School and College Text-books by the American Book Company, Chicago. Pages xl+507. 13x19 cm. Cloth. 1912.

This is a *real* book not a mere catalogue. It is undoubtedly one of the best publications to illustrate and describe the products of a firm's manufacture, ever published. The matter is splendidly arranged making it an easy matter to find that for which one is looking. In the description of each book listed, the purpose has been to set forth briefly and clearly the general features of the text under consideration, but at the same time to discuss more carefully the main characteristics of the book, those which distinguish it from other texts of the same general nature. The table of contents enables one to turn at once to the class of books in which he is interested. There is an alphabetical list in which the name of the author comes first, followed by the general name of the book, price and code word. A separate list is given of new and forthcoming books. Those who are purposing introducing new books should secure this descriptive catalogue and book as a guide.

C. H. S.

High School Education, edited by Charles H. Johnston, University of Kansas. Pages xxii+555. 14x19 cm. Cloth, 1912. Charles Scribner's Sons, New York.

There is no disputing the fact that there are many high schools in which the individual members plan their work without any help or advice from the principal or members of the faculty. In many cases teachers consider themselves thoroughly competent to handle their subject, in their school, better than anyone else and hence scorn the idea of securing help from any source. Happily this brand of instructors is fast disappearing, largely due from the fact that such books as this have shaken up the dry bones of self-conceit and scattered them to all the winds of heaven.

This book does not represent entirely the thoughts and ideas of its editor, but is a compilation of the writings of several well-known men, who were invited to coöperate in its production. Throughout the book the various writers have kept in front view the original purpose of the book, "that the life purposes of high school students constitute the ultimate objects of reference. It is intended primarily to appeal to all serious students of our modern high school, including state, county, and city superintendents, high school principals and teachers in service."

The work is divided into twenty-seven chapters. The ideas in each chapter, except in one instance, being discussed by different authors. The best comprehension of the book can be secured by naming the subject of the chapter with its author.

I—Current Demands upon the Program of Studies; II—The Disciplinary Basis of Courses of Study, Charles H. Johnson; III—History of Secondary Curriculums since the Renaissance, G. L. Jackson, University of Michigan; IV—Principles and Plans for Reorganizing Secondary Education, Colvin O. Davis, University of Michigan; V—Instruction: Its Organization and Control, Edward C. Elliott, University of Wisconsin; VI—Mathematics, L. C. Karpinski, University of Michigan; VII—Physics, Frederick E. Kestes, University of Kansas; VIII—Chemistry, J. E. Mills, University of North Carolina; IX—Biology, Arthur S. Pearse, St. Louis University School of Medicine; X—Physiography, William J. Sutherland, Normal School, Platteville, Wis.; XI—English, Joseph V. Denney, Ohio State University; XII—Public Speaking and Voice Training, Dwight E. Watkins, Knox College; XIII—Latin, Arthur T. Walker, University of Kansas; XIV—Modern Languages, W. H. Carruth, University of Kansas; XV—History, Civil Government and Political Econ-

omy, Wayland J. Chase, University of Wisconsin; XVI—Drawing, Free-Hand and Mechanical, Walter Sargent, University of Chicago; XVII—Music in the High School, Charles H. Farnsworth, Columbia University; XVIII—Moral Education and Training with a Suggested Course of Study, W. B. Arbaugh, Superintendent of Schools, Ypsilanti; XIX—Physiology and Hygiene, Charles S. Berry, University of Michigan; XX—Sex Pedagogy in the High School, Aldred S. Warthin, University of Michigan; XXI—C. H. Robinson, Normal School, Upper Montclair, N. J.; XXII—Commercial Education, Selby A. Moran, Ann Arbor High School; XXIII—Vocational Training in the High School and its Relation to Manual Training, E. C. Warriner, Superintendent of Schools, Saginaw; XXIV—Practical Arts for Girls, Charlotte J. Farnsworth, Columbian University; XXV—Psychology in the High School Curriculum, Irving Miller, Teachers College, Greeley, Colo.; XXVI—The High School Library, Theodore Koch, University of Michigan.

A valuable bibliography of sixty-two pages covering all phases of methods of school work is given. A complete nine-page, double-column index is appended. It is a book which all teachers who wish to be progressive should purchase, read and study. Mechanically it represents the highest art of book making. C. H. S.

A Guide for the Study of Animals, by Worrallo Whitney, Bowen High School, Chicago; Frederic C. Lucas, Englewood High School; Harold B. Shinn, Schurz High School, and Mabel E. Smallwood, Lane Technical High School. Pages 197. D. C. Heath & Co.

The book comprises eight chapters, the first of which is introductory in nature while the last contains a glossary and a discussion of poultry.

The principal objects of the work, as stated in the preface, are to present the subject of zoölogy from the point of view of the student rather than the subject and to consider the ecological and economic facts rather than those of morphological nature obtained by the old type method. Insects are first considered by a number of well-chosen exercises that should introduce the pupils to some important facts and principles as well as making him acquainted with some common and important forms of insect life. Then follows a chapter on "The Connection between Structure and Function," where the cell and some of the simpler forms of animal life are studied. In three other chapters are taken up: "Adaptation to Surrounding," "Adaptation for Protection from Enemies," "Adaptations for the Preservation of the Species." Under the last topic, the subject of reproduction is well treated.

The question method is very largely used to get information to the pupils. To answer these questions laboratory and library work must be done in most cases. Very little field work is asked for. The reason for this, stated in the preface is a good one, but some disappointment will attend this omission on the part of users of the book who know the special qualifications of the authorship to give information on this subject.

A very desirable and rather unique feature of the work, adapting it well to the beginner, is the very brief and elementary consideration of a number of familiar forms of animals in the first few pages for the purpose of arousing an "active and attentive interest" on the part of the pupil and introducing him to the laboratory method "by easy stages."

Some of the questions asked in the laboratory exercises are much too difficult for the pupil to answer from information obtained at first hand with the simple equipment to be provided him, according to the directions under the topic, "materials" with each exercise. Some of these are: What enables the fly to walk upside down? What senses and sense

organs has the maggot? The directions for obtaining and preparing the material seem too vague and general in a number of instances. In the lesson on the external structure of the fish, it is asked to have provided, "Small fresh fish, shallow pans or dishes of water, forceps, and scissors." If these small fishes should happen to be minnows or members of a number of other families, the blind sac of the stomach, and the distinct large intestine, which the pupil is asked to find, would not be present. In the directions for studying the eye of the fish, attention is called to the lid, lash, and tear-duct, as if these features were actually present. This is too misleading. More definite references to literature than are given would add much to the value of a work of this kind. Notwithstanding these few shortcomings, the work is on the whole a very good one and shows much careful thought on the part of its authors; and in the hands of properly qualified teachers, it could be made the basis of very good courses or give suggestions for much valuable work in elementary zoölogy.

T. L. H.

Mathematical Wrinkles, by Samuel I. Jones, Professor of Mathematics in the Gunter Biblical and Literary College, Gunter, Texas. Pages viii+321. 13x19 cm. Price, $1.65 net. 1912. Published by the author.

A problem stated in unusual terms or a mathematical puzzle will often catch the interest of pupils and lead them into a more thorough study of some topics in algebra or geometry. In this book there is not only a large selection of old and new catch questions and puzzles, but also many interesting problems and exercises to supplement the daily assignments from the text-book.

There are 252 arithmetical problems, 146 geometrical exercises, 260 mathematical recreations, and fifty pages of examination questions in arithmetic. Solutions and answers are given in sixty-eight pages. Complete solutions are given of the more difficult problems, but for the most part answers only are given. Short methods of computation are treated at some length, the discussion filling sixteen pages. There are thirteen pages of useful quotations on mathematics, and the last sixty-two pages include mensuration formulas, historical notes, and tables.

The volume is well printed and well bound, and is in all respects a most useful handbook for mathematics teachers. H. E. C.

All the Children of All the People, by William H. Smith. Pages viii+346. 13x19 cm. Cloth, 1912. $1.50 net. The Macmillan Company, New York.

This is a book in which is studied the attempts of our educational system to educate everybody. The author is perfectly familiar with this system as it exists now and as it has existed in the past. However reluctant one may be to pass adverse criticism upon our present-day methods of general education he must admit that it is failing in its purpose in many particulars. The attempt to compel a child to study some subject for which he has no liking or adaptation is sheer folly. The fundamental principles of our educational system are excellent. All the children of all the people cannot, however, be educated in the same way. Round sticks will not fill completely square holes. We are beginning to realize that the course must fit the child and not the child the course.

This book is a candid and careful study of the situation which is splendidly handled, the question being discussed in an unequivocal way. It is writtten by a master hand in a most interesting manner. Folk interested in the child and future high quality of citizenship should carefully study this book. C. H. S.

Theoretical and Physical Chemistry, by S. Lawrence Bigelow, University of Michigan. Pages xv+544. 81 drawings. 15x22 cm. Cloth, 1912. The Century Company, New York.

In attempting a review of this excellent book one hardly knows where to begin. It is an evolution of a series of lectures which the author has given, at the University of Michigan, for several years. It is a work in which every teacher of secondary chemistry and physics will find much helpful information as to facts and theories and also many suggestions as to the way in which different aspects of this subject should be presented to the pupil. The instructor in college chemistry will likewise find here a fund of knowledge and plans of presentation which will enable him to proceed wisely with his classes. There is probably no better book in print on this subject. Enough matter is presented to cover about three class periods per week for one year. No attempt has been made to avoid the use of mathematics, yet most of the demonstrations require for their understanding only a working knowledge of elementary algebra.

The text is divided into four sections. The first section, of three chapters, discusses the value of science in general. The second section, of seven chapters, treats of the ultimate constituents of matter. Section three, of nine chapters, presents the study of the properties of matter. The last section, of eleven chapters, centers upon the discussion of the processes of why substances become what they are.

The author has succeeded in producing a book which can be readily understood by the reader. He has apparently made an effort to avoid the use of too technical terms, an excellent feature. A complete index of eighteen pages is appended. It is a work which should be in the library of every school where chemistry and physics are taught.

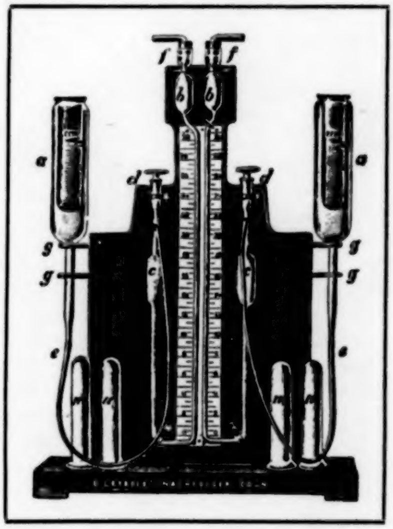
C. H. S.

The Mathematics of Applied Electricity. A Practical Mathematics, by Ernest H. Koch, Jr., Instructor in Mathematics, School of Science and Technology, Pratt Institute, Brooklyn, N. Y. Pages xvi+651. 14x20 cm. 1912. Price, $3.00. John Wiley and Sons, New York.

"This text was developed primarily for the mathematics instruction of second year students in applied electricity courses at Pratt Institute. It is intended to follow a year of drill in the essential elements of algebra, plane geometry, and plane trigonometry, and also in the elementary principles of mechanics, heat, and electricity."

The problem of giving students a grasp of mathematics that will enable them to do efficiently and understandingly the daily tasks of their chosen vocation, is reaching a solution in the work of Mr. Koch and other teachers of mathematics, who are in close touch with industrial life. In the present volume the student learns his arithmetic by working real electrical problems, though there are short lists of drill exercises of the academic type.

In the 278 pages of Part I the fundamental principles of arithmetic, algebra, geometry, and trigonometry are developed with sufficient explanations and illustrations to serve the needs of young men who have not studied these subjects in school. Most of the problems, except those in the chapters on mensuration and strength of materials, are in the field of electricity. In Part II, The Graphs of Formulas and the Formulation of Graphs, the practical use which is made of squared paper is an exemplification of the value of this work that ought to be seen by every teacher of secondary-school mathematics. The first part deals with problems of direct currents, while Part III, Vectors and Vector Diagrams, deals with alternating current problems.



This book will certainly prove of great value as a text in short practical courses in trade, industrial, and apprenticeship schools. It ought to be in the library of every secondary school, and on the desk of every mathematics and physics teacher. H. E. C.

Linear Polars of the k-hedron in n-space. A dissertation submitted to the faculty of the Ogden Graduate School of Science in candidacy for the degree of Doctor of Philosophy, by Harris F. MacNeish. Pages v+25. 17x24 cm. Paper. Price, 27 cents postpaid. The University of Chicago Press.

This treatment of polar theory is presented in six chapters: I, Synthetic Treatment; II, Analytic Treatment; III, Algebraic Loci; IV, Certain Configurations with Polarity Properties; V, The Reciprocity of Certain Associated Linear Sets of Points; VI, Concomitant Theory of the Associated 4-Point and 4-Line in the Plane.

H. E. C.

First Year Algebra, by Webster Wells and Walter W. Hart, Assistant Professor of Mathematics, University of Wisconsion Course for the Training of Teachers. Pages vi+325. 12x18 cm. 1912. Price, 90 cents. D. C. Heath & Co., Boston.

In this book Professor Hart has incorporated the course in algebra which he has been developing during the past eight years. The solution of equations and problems by means of equations is made the central topic as far as possible. Complicated forms and some of the less usefui complex processes are omitted. The factoring of each type of expression follows immediately the special products. There are problems of the new types, informational, motion, geometric, and so on. New ideas are developed in an inductive manner. The checking of results is encouraged. The graphical work, as in most of the algebras, is put in a "water-tight compartment." The historical notes are well written and are historical rather than biographical.

Pupils should be able to comprehend readily the explanations and illustrations which are well thought out and perspicuous, and they will doubtless find many interesting problems.

H. E. C.

The Energy System of Matter, by James Weir. Pages ix+200. 15x22 cm. Cloth, 1912. Longmans, Green & Co., New York.

An interesting book in which the author discusses some of the results of his study of natural phenomena in research work in physics, extending over many years. He believes that the great principle of energy conservation is true, not only in the universally accepted sense, but more especially in the particular sense with reference to separate bodies such as planetary masses in space; he maintains, therefore, that each planet or star forms within itself a complete conservational system entirely distinct and independent of any other mass in space of what so ever kind. This conclusion, then, necessarily involves the complete denial of the transmission of energy in any form across interplanetary space. In the book the author has attempted to substantiate this claim by direct terrestrial experimental evidence. He also denies the existence of any ethereal substance permeating all space.

The work is divided into three parts, each part being differentiated into several sections relating to the particular phase of the subject which he is attempting to prove. It is clearly written and an interesting book to read. All physicists should become familiar with the views here advanced. The book will doubtless bring to the author many adverse criticisms. C. H. S.

Commercial Arithmetic, by Gustavus S. Kimball. Pages viii+418. 15x21 cm. 1911. G. P. Putnam's Sons, New York.

Though this book was prepared for use in commercial courses in high schools, normal schools, and business schools enough of the subjects usually found in arithmetical text-books are included to furnish a well-balanced course. Recognizing the importance of thorough drill in fundamental principles and the need of accuracy in rapid calculation, the author provides a large number of oral and written exercises for rapid work. The attention of the pupils is often called to checks and short methods.

The commercial subjects are carefully treated and they conform to present usages and customs. Fourteen pages are given to bills, accounts, and statements; twenty-four to commercial discounts; forty-four to banks and banking; and eighteen to stocks and bonds. Teachers of commercial arithmetic who are looking for a new text-book should examine this text before making a decision. H. E. C.

The Euclidean or Common Sense Theory of Space, by John Newton Lyle, Bentonville, Ark. Pages 63. 13x19 cm. 1911. Price, 60 cents. John N. Lyle.

This book is divided into three chapters. The first discusses space under the following outline: Space is continuous, trinally extended, objective homogeneous, immaterial, inflexible, immovable, unbounded, and it is an entity, *sui generis,* neither psychical nor physical. In the second and third chapters it is the aim to show that a circle is not a regular polygon with an infinite number of sides.

It is the purpose of the author to show that a study of non-Euclidean geometry is rank foolishness. Some of the statements he makes are noteworthy, "The assumption that space has a fourth dimension is an assumption that two perpendiculars may be erected to a plane surface at a point in the surface." "The hypothesis of five dimensions is more absurd even than that of four dimensions, since it involves the assumption of three perpendiculars to a plane surface through a point in that surface." "A finite straight line is one that has two ends," also the converse, "A straight line that has two ends is finite." J. M. K.

Materials and Construction, by James A. Pratt, Williamson Free School. Pages xi+196. 13x18 cm. Cloth. 1912. 90c net. P. Blakiston's Son & Co., Philadelphia.

This is a treatise on elementary structural designs, and has been written for the purpose of giving those not versed in technical education an opportunity to apply in daily practice many of the more simple formulas appertaining to building construction of various kinds. Good judgment has been used in the selection of the practical problems with which the book abounds. It is a splendid work to use in trade schools and for the mechanic, too, who is unable to attend a trade school. A fund of helpful suggestions will be found which will enable him to wisely select those materials and use that form of construction which will give the best results. The educational value of the rough sketches is not the best, nothing is gained by them, a well-made drawing serves the purpose much better. There are nine chapters with headings as follows: Elementary Principles; Materials; Elementary Calculations and Properties; Beam Design; Columns; Torsions; Action of Elementary Forces and their Consideration in Design; Proportions of Knees and Corners; Riveted Joints; Reinforced Concrete; one gets an idea of the ground covered by this list of chapter headings. Many useful tables and data are appended. A good index is at the end. Main paragraphs begin with **bold face type.** A fine book for all structural mechanics. C. H. S.